BUILD A TRANSISTOR SHORTWAVE RADIO

RADIO-ELECTRONICS

AUGUST 1956

TELEVISION • SERVICING • HIGH FIDELITY

HUGO GERNSBACK, Editor

The Laboratory Golden Ear

•

Practical Checker For Transistors

•

TV Signal Troubles—Before the Receiver

•

Junction-Transistor Trigger Circuits

•

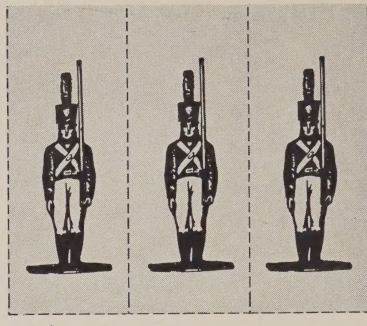
Transistorized Solar-Flare Indicator

35¢
U. S. and CANADA

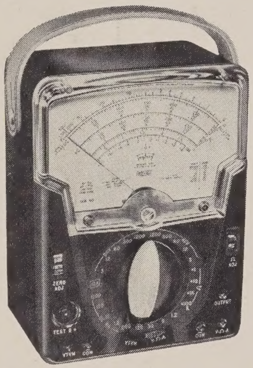
Electronic Scorer Re

See page 4

performance matched test equipment

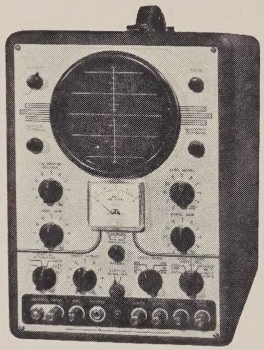


basic! fundamental! essential!



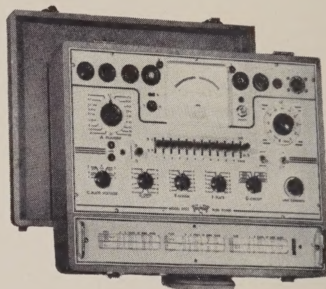
MODEL 631
VOM-VTVM

two in one tester for 100% service—VOM covers 90% of your usage, battery operated VTVM available for the other 10% when you need it. **$59.50**



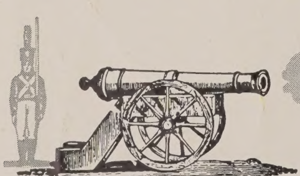
MODEL 3441-A

three in one scope—oscilloscope, peak-to-peak meter, audio oscillator—essential for more than 50% of your Black and White Servicing—all Color Servicing. 10 mv sensitivity. 4.5 mc bandwidth. **$249.50**



MODEL 3423

four in one—mutual conductance tube tester, transistor tester, germanium diode tester, selenium rectifier tester—checks for accuracy as circuit demands depending on the tolerance of the circuit. The patented circuit for the tube testing employs actual signal (4KC) for grid and DC bias voltage making it independent of line voltage hum. It also has a complete coverage of all tube types—six plate voltages (including 0-10 variable). Micromhos scales read 0-1,800, 0-6,000, 0-18,000 and 0-36,000. Leakage measured directly on meter 0-10 megohms. **$199.50**



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These three units provide the ideal basis for the complete servicemen's test setup. Don't make a mistake! Before you buy, ask your parts distributor to demonstrate these and many other Triplett units. Buy performance matched equipment!

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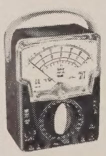
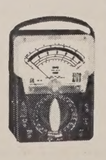
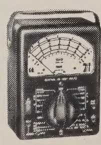


631
Combination V-O-M—VTVM

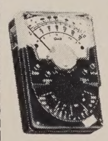


630-NA
For Best Testing Around the Lab, Production Line or Bench

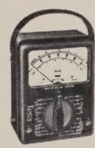


630
The Popular All-Purpose V-O-M

630-A
A Good Lab and Production Line V-O-M

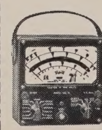


310
The Smallest Complete V-O-M with Switch



630-T
For Telephone Service

666-HH
Medium Size for Field Testing



625-NA
The First V-O-M with 10,000 Ohms/Volt AC

666-R
Medium Size with 630 Features

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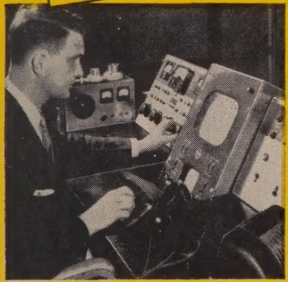
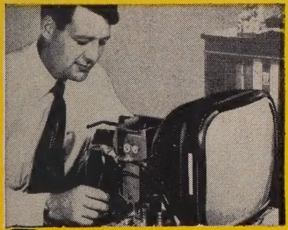


Make $10, $15 a Week Extra
Many men I train fix neighbors' Radios, make extra money, soon after they enroll. Actual equipment you build gives you practical experience.



America's Fast Growing Industry Offers You Good Pay Plus a Bright Future

TRAINING plus OPPORTUNITY is the PERFECT combination for ambitious men. Let me send you a sample lesson from my course to prove you can keep your job while TRAINING at home in your spare time for better pay and a brighter future. I will also send my 64-page book to show you that Radio-Television is today's field of OPPORTUNITY for properly trained men.

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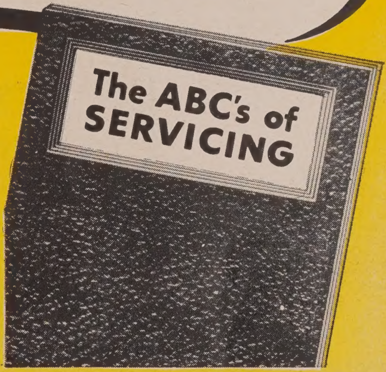
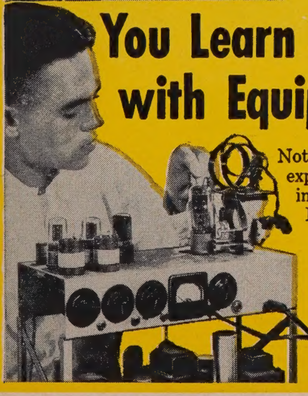


I Trained These Men

"I have a regular job as a police captain and also have a good spare time Radio and Television service business. Just opened my new showrooms and shop."—C. W. LEWIS, Pensacola, Florida.

"I decided to quit my job and do TV work full time. I love my work and am doing all right. If fellows knew what a wonderful investment NRI is, they would not hesitate."—W. F. KLINE, Cincinnati, Ohio.

"Thanks to NRI, I operated a successful Radio repair shop. Then I got a job with WPAQ, later WBOB and now am an engineer for WHPE."—VAN W. WORKMAN, High Point, N. Carolina.



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RADIO-ELECTRONICS

Formerly RADIO CRAFT • Incorporating SHORT WAVE CRAFT • TELEVISION NEWS • RADIO & TELEVISION*

AUGUST 1956 **Vol. XXVII, No. 8**

GERNSBACK PUBLICATIONS, INC.

Executive, Editorial and Advertising Offices, 154 West 14 St., New York 11, N. Y. Telephone Algonquin 5-7755.

ON THE COVER

(Story on page 50)

A new electronic scoring device frees the fencers from the old trailing wire used in previous electrical scoring equipment. The censors are Nancy Grimm of New Haven and Pauline Baker of Madison, Conn.

Color original by Tom Carew

Average Paid Circulation over 174,000

Associate Member of Institute of High Fidelity Mfrs., Inc.

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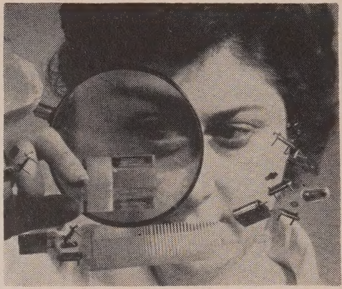
the Radio month

SOUND SLICES QUARTZ. A quartz crystal ultrasonically sawed into wafers by the Signal Corps Engineering Laboratories, Fort Monmouth, N. J., is shown in photo. Using an ultrasonic quartz cutter, three times as many slices were cut from a block of quartz



as would be possible with a conventional diamond saw, as shown in the lower block. The 21 razor-fine quartz wafers cut with the Army's new sound slicer are barely visible compared to the diamond-saw blanks alongside. Quartz crystals are vital to radar, radio communications and guided missiles.

PICTURE-TUBE IMPLOSIONS were the subject of a 10-point recommendation by the Radio & Television Servicemen's Association of Pittsburgh, to combat an outbreak of these occurrences. No less than five have been reported in the area during the past year. The Pittsburgh Fire Department has called on RTSA for help in conducting thorough tests in an effort to prevent further incidents which could be disastrous to viewers physically and are possible fire hazards.

Interest was touched off after two recent implosions literally blew parts and debris all over the owner's room. And major cause for concern is the close proximity to the sets that children usually seek. There was a report of an implosion after the owner had turned the set off and gone to bed.

B. A. Bregenzer, chairman of RTSA'S public safety committee, is seeking answers to the questions: Why have implosions been reported only in the past few months? Have they existed since TV became a nationwide habit? And if so, why weren't the occurrences reported? Are implosions a local condition or more widespread?

RTSA's recommendations include a suggestion that all TV receivers be equipped with reliable safety glass (some safety glass or plastic may not be adequate); rears of sets be made implosion-proof; the strength of cabinets be adequate to restrain flying glass, especially in the case of 24-, 27- and 30-inch tubes; picture tubes be installed only by experienced personnel.

GEORGE H. CLARK, PIONEER in wireless telegraphy and associated with RCA for 27 years, died on June 3 at the age of 75. Affiliated with the Marconi Wireless Telegraph Co. of America, following wireless service with the Navy during and before World War I, Clark (see photo) joined RCA when it acquired Marconi in 1919.

From 1919 to 1931 Clark managed the RCA exhibit division. From 1931

until he retired in 1946, he collected and cataloged files of early radio companies, photographs, blueprints and similar matter concerning the early days of the radio industry and its pioneers. In 1952 this "RCA–Clark Collection of Radioana" was presented by RCA to Clark's alma mater, MIT.

Clark was a founder and former president of the Veteran Wireless Operators Association and the author of biographies of Roy Weagant (inventor of the Weagant circuit) and of John Stone, whom he considered the greatest of the early radio engineers.

FIVE NEW TV STATIONS have gone on the air since our last report:

WESH-TV Daytona Beach, Fla.......... 2
WCBI-TV Columbus, Miss.................. 4
WDAM-TV Hattiesburg, Miss. 9
WTRI Albany-Schenectady-Troy, N. Y.......................................35
WKNO-TV Memphis, Tenn.................10

WICA-TV, Ashtabula, Ohio, channel 15, has gone off the air.

KULA-TV's recent change of call letters to KTCA has been cancelled. It remains KULA-TV, Honolulu, T. H., channel 4.

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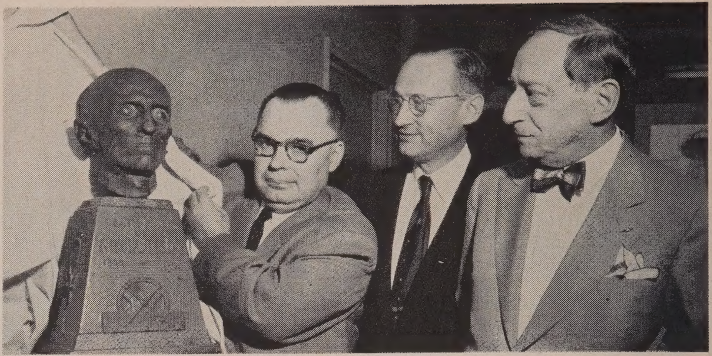


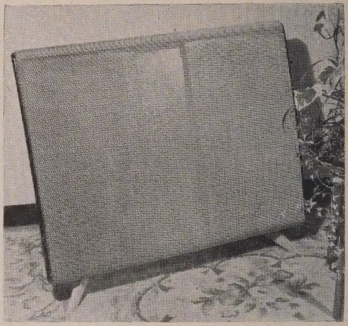
Memorial to Nikola Tesla is unveiled by Lazar Lilic, Consul General of Yugoslavia in New York, in a ceremony held June 25 at the offices of RADIO-ELECTRONICS. The accomplishments of Tesla, possibly the greatest inventor who ever lived, are reviewed briefly in our July issue, pages 6 and 29. Beside Mr. Lilic is John T. Morris, Westinghouse patent attorney and, at right, Hugo Gernsback.

60-FOOT RADIO TELESCOPE has been dedicated at the Agassiz Station of the Harvard Observatory, Harvard, Mass. The huge paraboloid antenna, named in memory of George R. Agassiz, famous benefactor of Harvard astronomy, receives celestial radiation which is then fed to intricate electronic recording equipment.

Particularly important radiation comes at a wavelength of 21 centimeters from the great, lightless clouds of neutral atomic hydrogen which float between stars. As this is recorded, an electronic mapping of previously unseen regions results. Cosmic dust clouds prevent optical study of other distant parts of our galaxy. But radio waves penetrate this "interstellar fog" (and the water vapor of our atmosphere) with ease.

The antenna uses a one-piece bowl of aluminum mesh, weighing 8,000 pounds, and is set on a concrete foundation 12 feet deep. It can be tilted and turned to face any portion of the sky.

ELECTROSTATIC LOUDSPEAKER covering the full audio range (see photo) was demonstrated recently at the London Audio Fair. Previous electrostatic speakers required a woofer to cover the lower part of the audio spectrum. The lowest range handled on earlier units was in the order of 400 cycles;



the *Acoustical* goes down to 40. Made by the Acoustical Mfg. Co., Huntingdon, England, the loudspeaker's frequency response is smooth, having no undamped resonances either in the mechanical system or in its acoustic loading—there is no cabinet. Because of the constant unit-area charge, the loudspeaker is said to be virtually distortionless from 40 cycles to well above the range of human hearing. The overall size is 33 x 25 x 3 inches, with the base slightly deeper to hold the polarizing power supply. END

Calendar of Events

AUGUST—1956

1956 Western Electronic Show and Convention (WESCON), Aug. 21–24, Pan Pacific Auditorium, Los Angeles, Calif. (RADIO-ELECTRONICS will exhibit in York, N. Y.

23rd Annual British Radio Show, Aug. 22–Sept. 1, Earls Court, London, England.

Southern Arizona Hamfest, Sept. 1–3, Fort Huachuca, Ariz.

New York High Fidelity Show, Sept. 26–30, New York Trade Show Building, New York, N. Y. (RADIO-ELECTRONICS will exhibit in Room 523.)

Canadian IRE Show and Convention, Oct. 1–3, Automotive Building, Exhibition Park, Toronto, Canada.

National Electronics Conference and Exhibition, Oct. 1–3, Hotel Sherman, Chicago, Ill.

Correspondence

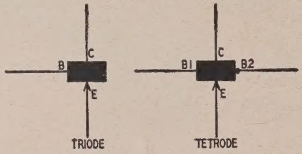
TRANSISTOR SYMBOLS

Dear Editor:

I would like to propose a new symbol for transistors (see diagram). The present symbol does not show in any way whether a transistor is of the junction or point-contact type.

As vacuum tubes of different structures were developed—diodes, triodes, tetrodes, pentodes, electron-ray, photoelectric, etc.—different symbols were added. And it is just as reasonable that new symbols should be added as different transistor structures are developed.

Since the conventional symbol resembles the physical layout of the point-contact transistor, it should be used to represent them only. And since the symbol shown here represents the physical layout of the junction transistor, it should be adopted for that type. JAMES E. PUGH, JR.



Menominee, Mich.

(Mr. Pugh's original drawings contained circles around the transistors. These were irrelevant to the present discussion, but it might be convenient to use circles around both junction and point-contact transistor symbols. —*Editor*)

BASEMENT REPAIRMEN

Dear Editor:

Two of the letters in the June issue of RADIO-ELECTRONICS, from B. S. Ward and J. H. Sutton, were of special interest to me, as I am occasionally one of the "basement" type TV repairmen; my full time occupation is radar technician. On a recent quest through several local radio–TV–appliance stores in search of a 3-watt 115-volt bulb to use in an audio oscillator, I was surprised at the lack of interest and knowledge in the *general* field of electronics on the part of the local full-time service technicians. Too many, to my way of thinking, are ignorant of basic electronics theory and succeed at TV repair through the application of memorized rules and procedures while ignorant of the *why* of what they are doing.

It is only to technicians of this caliber that we can attribute the type of repairs represented in Mr. Sutton's

(*Continued on page* 14)

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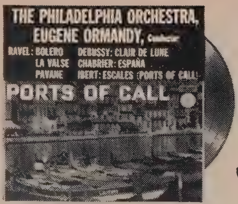

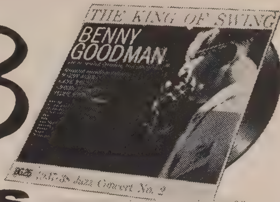

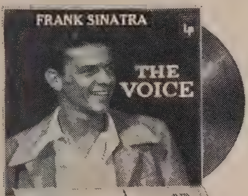

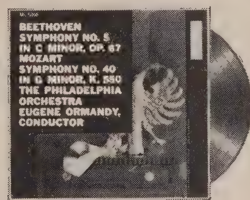

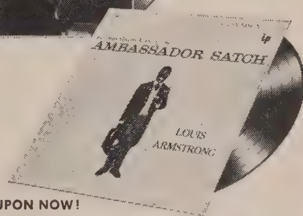

1 Ports of Call
Philadelphia Orch., Ormandy, conductor. *Bolero, La Valse, Pavane, Clair de Lune, Escales, España.*

2 The Voice
Frank Sinatra sings 12 numbers that first brought him fame like *Fools Rush In, I Don't Know Why*, etc.

3 King of Swing: Vol. I
Benny Goodman and his Original Orchestra, Trio and Quartet. *Ridin' High, Peckin', Moonglow*—8 more.

4 My Fair Lady
Percy Faith and his Orch. play the score from this hit show.

5 Mendelssohn: Violin Concerto Tchaikovsky: Violin Concerto
Francescatti, violin; N. Y. Philharmonic, Mitropoulos, conduct.

6 I Love Paris
Michel Legrand and Orch. play *La Vie En Rose, Paris*—12 more!

7 Jazz: Red Hot & Cool
Dave Brubeck Quartet in *The Duke, Love Walked In*—6 more.

8 Levant Plays Gershwin
3 works—Rhapsody In Blue; Concerto in F; American in Paris.

9 Saturday Night Mood
12 popular bands play favorite dance music. Jimmy Dorsey, Les Elgart, Les Brown, Sammy Kaye and others.

10 Symphony No. 5 Beethoven: Mozart: Symphony No. 40
Philadelphia Orch., Ormandy, conductor.

11 Music of Jerome Kern
Andre Kostelanetz and his Orchestra play 20 Kern favorites.

12 Ambassador Satch
European Concert Recordings by the great Louis Armstrong and his All-Stars.

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5621	5821	6821
5622	5822	6822
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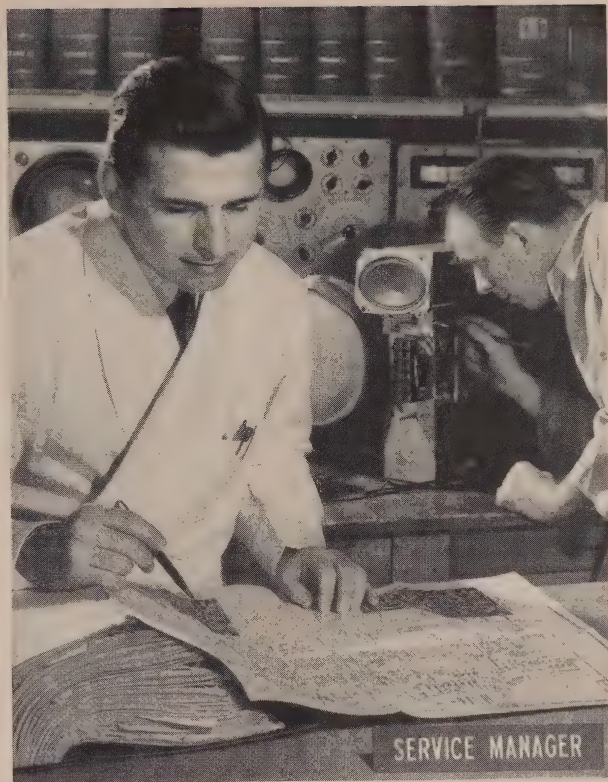

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Installing front-end channel selector strips in modern UHF-VHF Television receivers and learning UHF servicing problems and their solution is part of the practice you get if you live in a UHF area. To cash in on the coming color TV boom you'll need the kind of knowledge and experience which this training gives.

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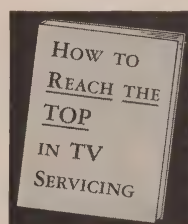

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letter, and I think it only fair to request those who would censure the independent technician to first examine their own colleagues. I think they would find many who are adept at changing tubes but don't know electronics.

KENNETH M. BARBIER, JR.
Lancaster, Calif.

PROVE COMPETENCE

Dear Editor:

Mr. Wolfson's letter in the May issue deserves some comment from technicians who, after careful and searching consideration, have aligned themselves in the opposing camp. I am one of these; I am for licensing!

The day of the horse and buggy has long gone. Barbers are no longer "surgeons" and "bleeding" has long since become recognized as a fraud (though some naive souls may still have faith in it). Today's world is a complex one and television receivers are prominent examples of that complexity. To imply otherwise is to close one's eyes to reality. Sure it would be nice if there were no need for traffic laws, for slum maintenance codes, pure food acts and all the other ordinances to protect citizens from fraud, negligence and cupidity. But man's inhumanity to man is too well known and recognized to need any amplification here.

Is it too much to ask that a man engaged in servicing television receivers prove his competence? Is it too much to insist that he protect the good name of his fellow technicians by dealing fairly and ethically with the public?

Is it vindictive to hold him responsible for his acts?

The overwhelming majority of technicians have nothing to fear from licensing. The inept, the untrained and the gyps have. Mr. Wolfson's fear of persecution is the stuff of which nightmares are made; it exists only in his imagination; it has no substance; it is not supported by facts. Doctors, lawyers, nurses, electricians, pharmacists, radio operators and vendors of various kinds have been licensed for some time now, and I have never heard of any of them being persecuted. Some malpractitioners among them have been but this is to the advantage of all who believe laws are made to be observed, not to be violated at will.

H. M. LAYDEN
Chief Technician,
Judd-Bennett Co.,
New York, N. Y.

TEST EQUIPMENT NOTE

Dear Editor:

In all of RCA's TV service notes, under the heading Horizontal Oscillator Adjustment, the final line always reads: "Remove the oscilloscope upon completion of this adjustment."

Say now! I shoulda read this before! I just betcha that's where my old scope went when it suddently turned up missing a couple of years back!

H. A. HIGHSTONE
Santa Rose, Calif. END


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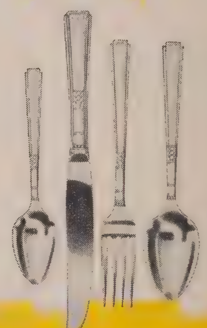

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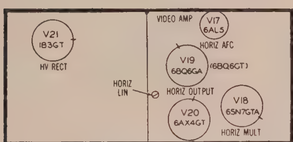
how long would it take you to solve this service problem?

SYMPTOM:

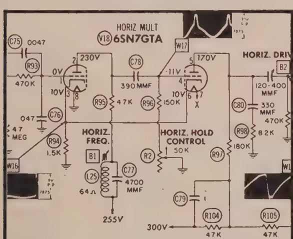
Loss of horizontal hold. Hold control will not pull the picture into synchronization. Sound is normal.

There's no telling how long it might take to solve this problem with hit-or-miss methods—it's been known to take hours. With a PHOTOFACT Folder by your side, the job takes just minutes. Here's why:



In just seconds, you locate the tubes most likely to cause this symptom by referring to the Tube Placement Chart* and Tube Failure Check Chart* you'll always find in the same place in each PHOTOFACT Folder.

In this case the trouble wasn't caused by tube failure, so...



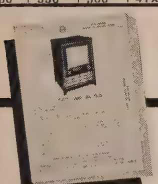
In just seconds you refer to the Horizontal Circuit on the Standard Notation Schematic* featured exclusively in all PHOTOFACT Folders. Circuits are always laid out in the same uniform manner. The Horizontal Circuit is always located in the lower center of the schematic. In a matter of minutes you check waveforms and voltages—they're right on the schematic. And in those same few minutes you find the answer to the problem in this case history. The waveform at W17 and the voltage reading at Pin 4 show a leaky coupling capacitor C78. Yes, you have your answer in just minutes!

C74	270	500	RCM20A271K	SI270	D6-271
C75	.0047	400	RCP10M4472M	SI4700	D6-472
C76	.047	200	RCP10M2473M	BPD-05	DF-50
C77	4700	500	47X543	1464-0047	
C78	390	500	RCM20B391J	1469-00039	D6-391
C79	.1	400	RCP10M4104M	P488N-1	DF-104
C80	330	500	47X570	1469-00033	D6-331

And PHOTOFACT, through its accurate Parts Listings*, instantly gives you a choice of the proper replacement required to accomplish the repair. You save even more time!

From start to finish, you solve your service problems in just minutes...you service more sets and earn more daily with PHOTOFACT by your side!

*One of 32 features found exclusively in PHOTOFACT—the world's finest service data



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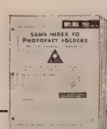

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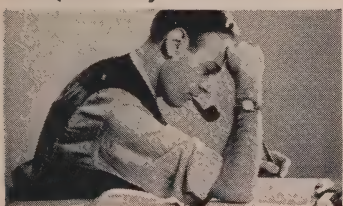

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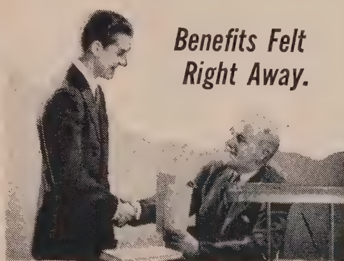

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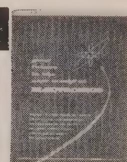

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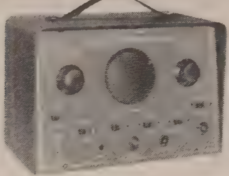

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Unique principle locates intermittents, detects borderline components Fast—

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Locate intermittent capacitors, resistors, coils, chokes, tubes, and other component and hidden wiring failures in minutes—without waiting. Exclusive Wintronix circuit using modulated special r-f test signal, immediately makes any radio or TV receiver super-sensitive to intermittents—gives both audible and visible indication so you can pin-point trouble right away. Reduces callbacks by detecting borderline components *before* they fail.

Dynamic SWEEP CIRCUIT ANALYZER

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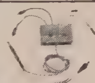

Model 915/960 Troubleshoot sync circuits by signal substitution. This unit with Model 820 injects (+) or (—) pulse voltages into vertical and horizontal sync stages. Locates defective sync separators, sync amplifiers, AFC, and vertical integrator circuits.

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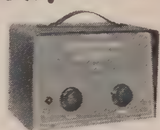

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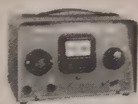

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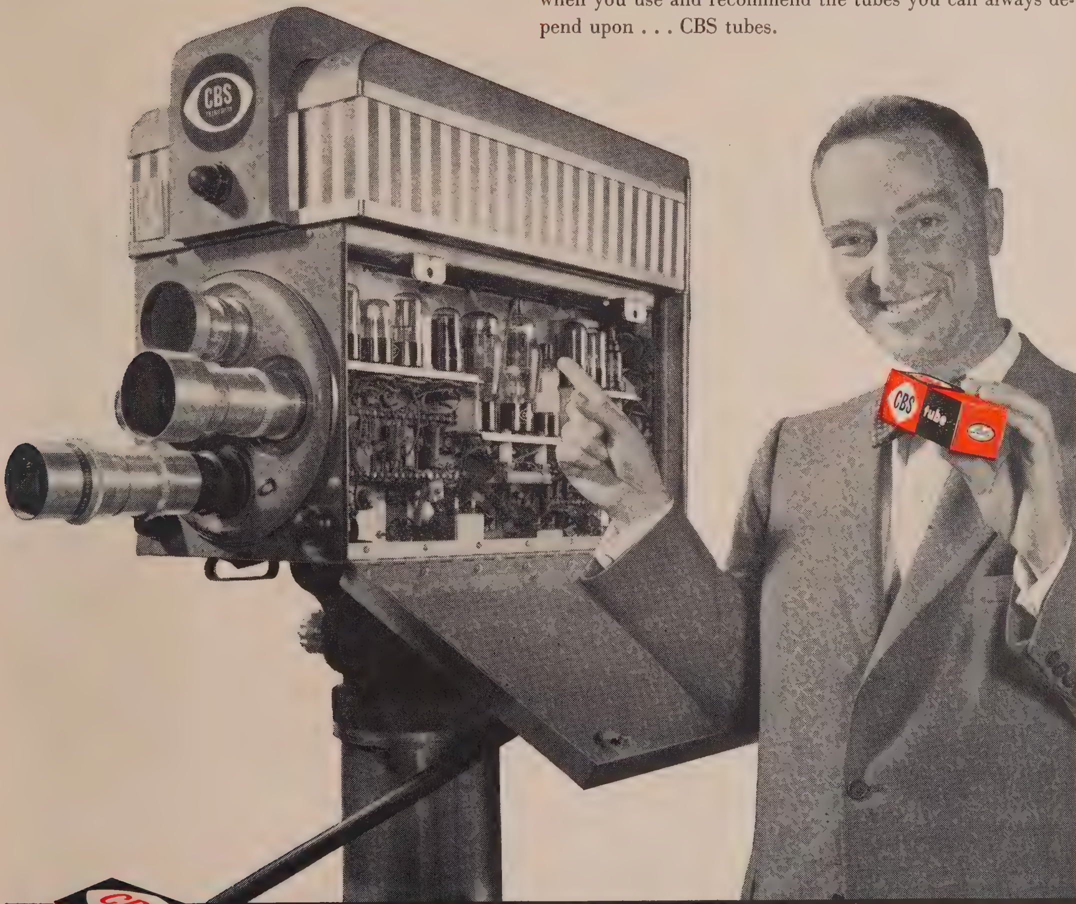

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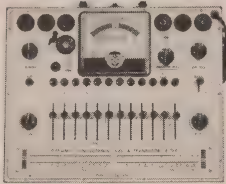

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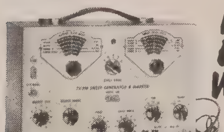

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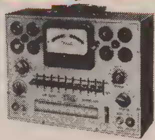

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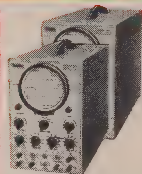

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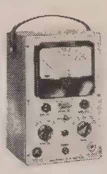

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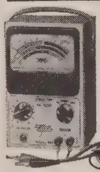

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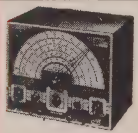

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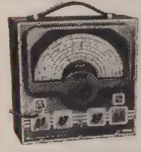

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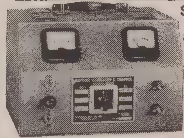

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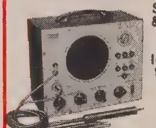

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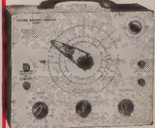

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RADIO-ELECTRONICS

Hugo Gernsback, Editor

MINITELEVISION

. . . Miniature TV's—even pocket sets—are now on the horizon . . .

WHEN we first spoke of *Miniradios* in the September, 1944, issue of this magazine,* there were no true pocket radios, let alone vest-pocket receivers, on the market. Only recently, due to mass production of transistors, have miniradios become possible. Further miniaturization—down to the size of a cigarette pack and smaller, which we foresaw in our 1944 article—is feasible now.

Literally millions of such tiny receivers will be sold in the future, when and if the prices drop sufficiently to take such radios out of the luxury class. There is a crying demand for true miniradios that can be concealed in the hand and which do not bulge in a man's vest pocket or a woman's purse. Such tiny sets are needed chiefly for news and weather reports, particularly in times of stress.

Inasmuch as television has followed many radio trends in the past, we may be certain that TV, too, will parallel the path of miniaturization in the foreseeable future. The huge television sets in our living rooms are by no means doomed—*large-screen* sets for family entertainment will always be with us—but they will take the form of a picture frame on the wall.

Recent trends have shown that smaller, portable TV's are booming—and deservedly so. With so many diversified programs on the air, families are often divided as to what individual members wish to see—hence the extra receiver. Yet while the smaller TV set, weighing 22 pounds and measuring 10 x 9 x 12 inches, or less, is a success, it is by no means the ultimate in small size.

Portable battery minitelevision receivers (which can also be plugged into the house current and car current supply for outings) are now on the horizon. Such minute TV sets may conceivably evolve in a number of different ways:

1. A very compact set, the size of a cigar box or smaller, transistor-operated with a projection type picture tube will be feasible during the next few years. A collapsible plastic or fabric screen to give a picture 7 or 8 inches wide would assure good viewing for several people. Such a receiver would weigh around 5 pounds.

2. A still smaller set with a brilliant 3-inch picture tube, giving high definition is another future possibility. It is admitted that from past experience, people object to a 3 x 4-inch picture—not because it is too small, but because you must view it from too close. Hence, the TV set manufacturer will furnish a pair of *adjustable* viewing eyeglasses. These eyeglasses are a low-priced type of binocular and enable one to view in comfort a program coming from a 3-inch screen from a distance of several feet away. This will be an ideal table or desk television receiver that can be taken from room to room, for traveling or for the office. The eyeglasses weigh only a few ounces and can be bought separately if more than one person wishes to use the same TV set. They are obtainable in the market now.

3. A much smaller minitelevision receiver is possible, a *personalized* one, that has no picture tube incorporated in it. Instead there are *two* miniature picture tubes, each with a ½-inch screen. The tubes would be only 2 inches long. They are attached to an eyeglass frame which brings the tiny picture less than 1 inch from your eyeballs. We described these "television eyeglasses" exactly 20 years ago.† A thin flexible connecting cord goes from the eyeglass frame to the minitelevision set. All the controls are on the set. The eyeglasses, with the tiny picture tubes, are only for viewing purposes. As the eyes come very close to the picture, there will be little eyestrain—programs can be viewed comfortably even when lying down. The viewing effect is as if one looked through a pair of good binoculars.

Such television eyeglasses will be especially desirable for sick people in bed, at home or in hospitals. As such a set, with its TV eyeglasses, is small and light, it is easily transportable. It will have hundreds of uses, for the office and industrial purposes, for remote control supervision and others.

4. This does not by any means exhaust all the possibilities of minitelevision. We foresaw the "television wristwatch" in 1945; admittedly far-fetched at that time, it cannot be called impossible today, although it may take many years before it will be a commercial or practical possibility.

A more feasible mini-TV is an actual "TV pocket set." This would be about the size of our present radio pocket sets, which weigh a little over 1 pound and measure 6 x 3½ inches. Battery- and transistor-operated, such a TV set would have a special picture tube that would throw a reflected image on a 3½ x 2½-inch screen in the back of the set—ample for a personalized TV receiver. It will make an ideal set for young and old in the not very distant future —*H. G.*

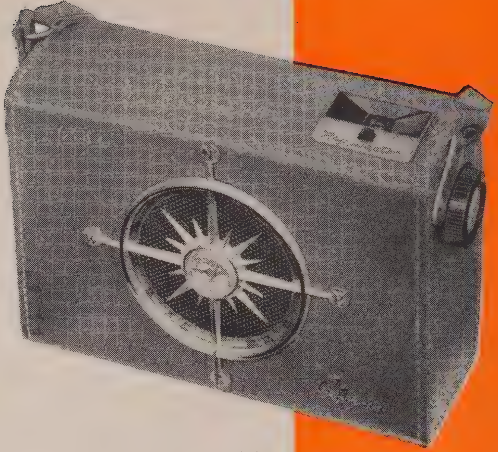
* See also "Miniradios," November, 1953, RADIO-ELECTRONICS.

† See October, 1936, issue of SHORT WAVE CRAFT, page 325, "The Future of Short Waves," by H. Gernsback.

TRENDS in AM RECEIVERS

The radio has not been forgotten—here is a review of interesting advances

By ROBERT F. SCOTT
TECHNICAL EDITOR



Sylvania's U-235 Prospector.

IN recent months there have been a number of interesting innovations in the design and construction of home, portable and automobile radios. These new developments may well set the pattern for sets produced in the future. Among the most interesting of these is an automobile radio receiving all its operating voltages direct from the battery without a separate B supply, a combination portable radio and G-M counter, an ac–battery portable with a transistorized B supply, a combination radio and intercom and a three-way all-wave portable with Standard Coil type bandswitching turret.

New auto radio

Models CTA6T, 6TAS8, BKA6T and similar 1956 Motorola auto radios are designed for cars with 12-volt ignition and lighting systems and *all* plate, screen and heater voltages are fed directly from the battery. There is no vibrator B supply!

These sets are fairly conventional circuitwise—except for the audio amplifier—and they use tubes specially designed for low-voltage operation. The three-stage audio amplifier has a single transistor output stage delivering a maximum of 4 watts. Another feature is an auxiliary avc system—Motorola calls it Volumatic—that operates on the first *audio* amplifier stage. The circuit of model BKA6T is shown in Fig. 1.

A new thing in the electronic field — tubes that operate with 12 volts B supply (less than needed for some transistors) are the only types used in the Motorola automobile receiver described here.

The 12AC6's in the rf and if amplifiers, the 12AD6 converter, 12F8 detector, avc and first audio and 12K5 driver are all designed to provide satisfactory operation with 12-volt plate and screen voltages. (The 6TAS8 uses a 12CR6 diode–pentode in the detector and first audio circuit.)

Noise-pickup eliminator

Motorists often enter areas where power-line noise is high. This type of interference is minimized in new Motorola sets by high-pass filter R1–C1 (Fig. 1) designed to attenuate low noise frequencies without affecting the incoming broadcast signal.

The rf amplifier plate circuit is tuned and R-C-coupled to the grid of the 12AD6 converter. The detector, avc and first af amplifier is a diode–pentode rather than the diode–triode combina-

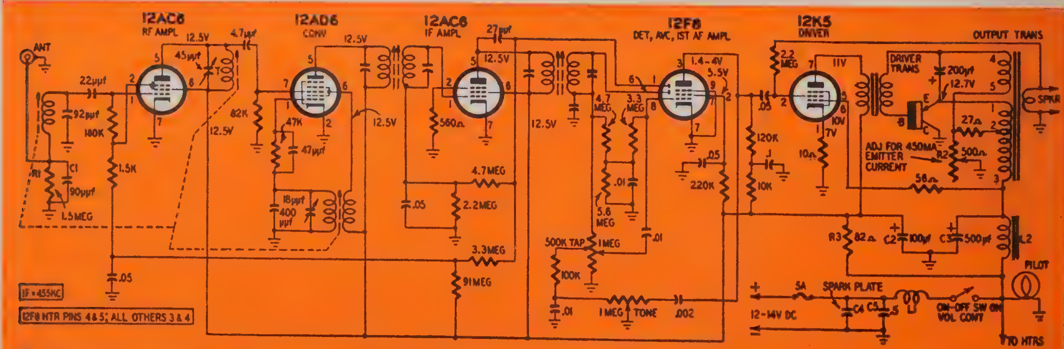
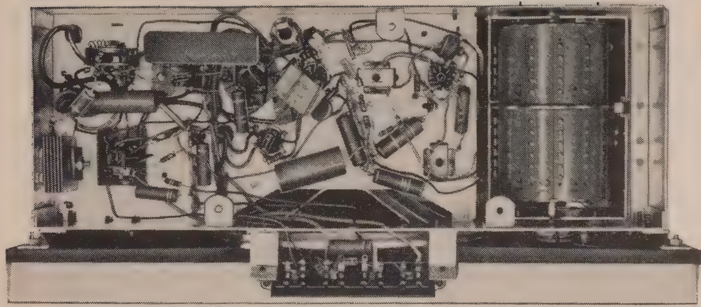


Fig. 1—Schematic of the Motorola model BKA6T automotive type receiver with transistor output—no separate B supply.



Underchassis view of Hallicrafters portable showing turret strips.

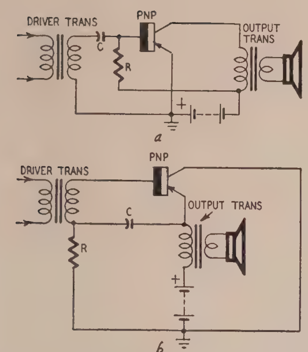


Fig. 2—Transistorized output circuits with positive and negative grounds.

tion popular since the 2A6, 55 and similar types were introduced around 20 years ago. The 12F8 and 12CR6 have remote-cutoff pentode sections especially designed for audio circuits where avc voltage is applied to the control grid for improved performance. In auto radios, the Volumatic circuit holds the signal at a listenable level while passing through an underpass or over a large steel bridge. It also minimizes changes in volume when switching from a weak to a strong station.

The detector load consists of the 1-megohm volume control shunted by series-connected 4.7- and 5.6-megohm resistors. The pentode operates with grid leak bias as in most circuits. But in this one the grid resistor (3.3 megohms) returns to the junction of the 5.6- and 4.7-megohm resistors instead of to ground. Thus, the dc grid bias varies with the strength of the incoming signal. Strong signals increase the bias and reduce the audio gain, weak signals increase the audio gain by decreasing the bias.

Rf and if avc

The avc voltage for the rf and if circuits is developed by the second diode (pin 1 of the 12F8) capacitance-coupled to the if amplifier plate. A bucking or delay bias is applied to the diode plate from the 12-volt plus line. The avc voltage is developed across the 4.7- and 2.2-megohm resistors between the diode plate and ground.

The control voltage for the rf and if circuits varies so that the front end operates practically wide open on moderate signals. The avc voltage for the rf amplifier is applied to the control and suppressor grids. Strong signals that would normally cause overloading and cross-modulation *drive the rf amplifier to cutoff*. In this case, the incoming signal is fed directly to the converter grid through the interelectrode capacitance between plate and suppressor. Note that the suppressor and control grids of the 12AC6 rf amplifier are connected together through a 180,000-ohm resistor.

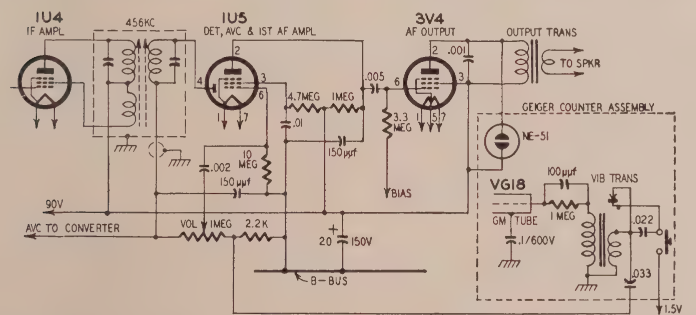


Fig. 3—Partial Prospector schematic, a three-way portable and Geiger counter.

Driver and output circuits

The 12K5 is a *space-charge tetrode* designed for use as a power-amplifier driver in circuits where all operating voltages are taken from a common 12-volt dc source. It supplies 35 milliwatts of driving power. In this application, the signal is applied to the control grid (grid 2) and the space-charge grid (grid 1) operates at or close to plate potential.

A transformer matches the 800-ohm plate load impedance to the transistor input impedance of around 10 ohms. The transistor output stage uses a p-n-p junction type unit in a common-emitter circuit with the collector grounded to permit the set to be used in cars with grounded-negative batteries. The problem of adjusting the set for a given circuit polarity is practically eliminated now because the negative ground is al-

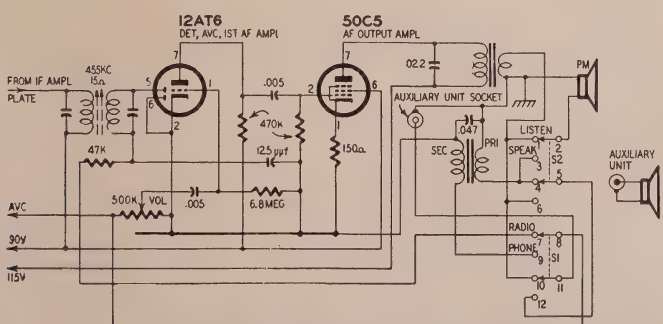


Fig. 4—Audio and intercom circuitry of the Sylvania ac–dc model 1102.

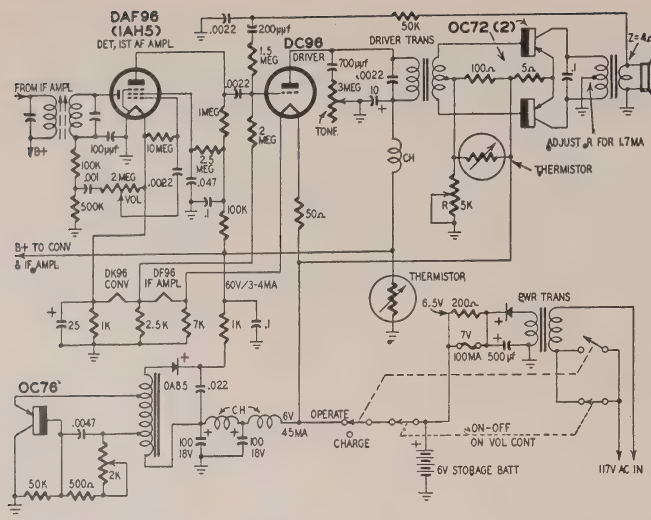


Fig. 5—Grundig's Transistor Boy L audio and power-supply circuits.

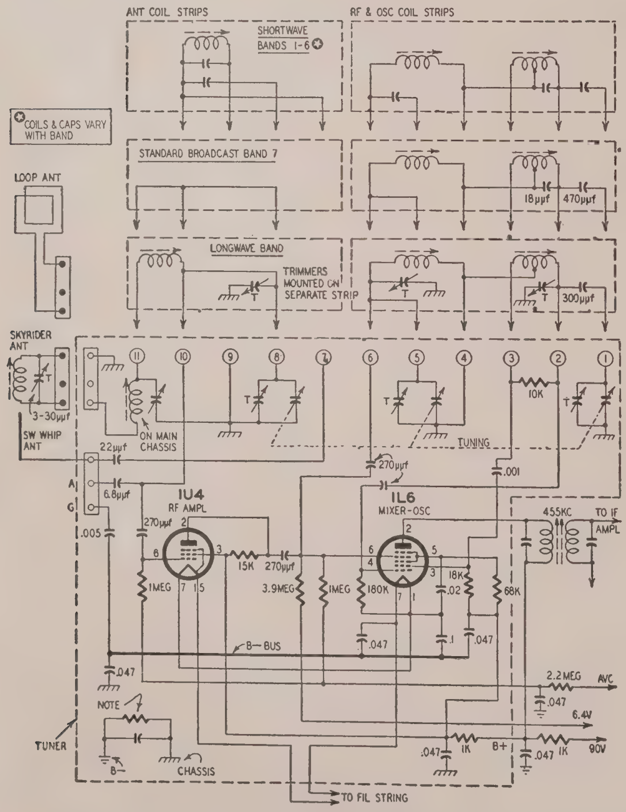


Fig. 6—Front-end circuitry of the Hallicrafters TW-1000.

most universal in new cars with 12-volt ignition systems.

The transistor is mounted on a finned aluminum heat sink on the side of the receiver's case for adequate cooling. The collector is tied to the transistor case and thus is grounded when the unit is installed in the receiver.

Fig. 2-a is a transformer-coupled p-n-p transistor amplifier with grounded-positive power supply as used in many applications. This corresponds to the conventional grounded-cathode vacuum-tube amplifier. Blocking capacitor C prevents bias developed across R from being shorted out by the driver transformer secondary.

This arrangement is not practical in these receivers so the circuit is converted to the equivalent of a grounded-plate vacuum-tube amplifier. Its transistor equivalent is shown in Fig. 2-b. In Fig. 1 the resistor has been replaced by a tertiary winding (terminals 4 and 5) on the output transformer. This winding has a high impedance at audio frequencies so the driver signal is effectively applied between base and emitter through the low impedance of the 200-μf coupling capacitor corresponding to C in Fig. 2. Potentiometer R2 (Fig. 1) adjusts the emitter current to the optimum value—450 ma. The base return is connected to a tap (terminal 2) on the primary of the output transformer to improve the low-frequency response at around 100 cycles. Feedback from the voice-coil winding to the driver grid is used to reduce distortion.

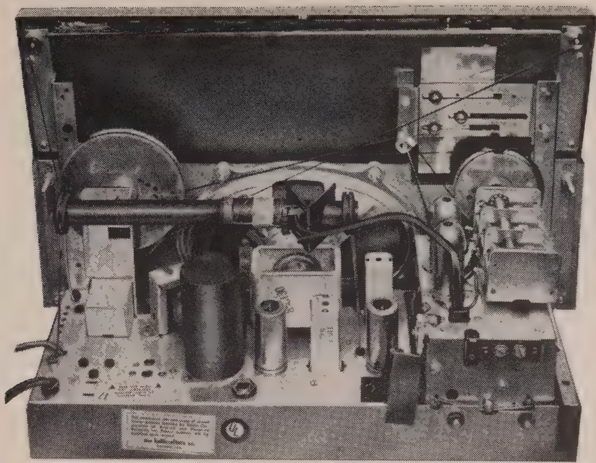
Noises originating in the car's electrical system are eliminated with filters in the hot A line; L1, C4 and C5 make up a filter to remove high-frequency ignition noises; L2–C3 and R3–C2 remove low-frequency interference caused by the distributor rotor in the car's ignition system.

Radio–G-M counter

Portable radios are an essential source of weather reports and news for prospectors in remote areas. The Sylvania Prospector, which carries the appropriate model number U-235, is a combination three-way portable radio and Geiger counter with a magnetic compass and sun dial built into the front panel.

A partial schematic of the Prospector (model 3041, chassis 1-612-1) is shown in Fig. 3. The Geiger counter is powered by a vibrator type high-voltage supply operating off one of the 1.5-volt cells in the filament supply. When the switch is closed momentarily, the vibrator starts and a high voltage is induced in the secondary of the vibrator transformer. The G-M tube acts as a rectifier to charge the 0.1-μf 600-volt capacitor. The charge across this capacitor is the voltage source for the G-M tube and maintains itself for a considerable time when counting.

When the tube is exposed to radioactivity, it breaks down and current pulses flow through the high-voltage



Top chassis view of the Hallicrafters TW-1000 shows the turret type tuner.

winding of the vibrator transformer and induce voltage pulses in the low-voltage winding. These pulses are tapped off through the .033-μf capacitor and applied across the 2,200-ohm resistor between the low side of the volume control and B minus. (The control should be set to the minimum-volume position for best results with the counter.) The pulses are amplified in the set's audio system to produce audible clicks from the speaker and flashes in the neon lamp across the primary of the output transformer.

The G-M tube is a Victoreen halogen type for detection of gamma radiation. It operates with a starting voltage of 350 to 450 and produces pulses of approximately 75 volts. Background count is approximately 4 per minute and sensitivity 600 counts per minute per milliroentgen per hour.

Radio–intercom

Fig. 4 is a partial schematic of Sylvania's new model 1102 ac–dc radio–intercom. The receiver circuit is conventional with a 12BE6 converter, 12BA6 if amplifier; 12AT6 detector, avc and first af amplifier and 50C5 power amplifier. The cable to the remote station plugs into a phono type jack on the chassis. The talk–listen and radio–intercom switches are mounted on the side of the set's cabinet.

The dpdt slide switch S1 selects radio or intercom operation. One section closes or opens the detector load circuit and the other sets up the speaker circuits for proper operation. S2 is the talk–listen switch. When S1 is in the RADIO position, the program is heard at both positions when the remote or auxiliary unit is plugged in. The speakers of both units are in parallel. The circuit to the voice coil of the main speaker is completed through contacts 1 and 2 of S2 and the circuit to the remote is completed through contacts 10 and 11 on S1.

To convert to intercom S1 is thrown to PHONE. When S2 is in its normal (LISTEN) position, the voice coil of the remote speaker connects across the low-impedance primary of an audio input transformer. The ungrounded side of this transformer feeds through contacts 8 and 9 of S1 to the hot side of the volume control. Signals originating at the remote are amplified and fed to the master speaker through contacts 1 and 2 of S2.

When the talk–listen switch is thrown to SPEAK, the circuits to the voice coils are reversed so signals from the master are heard at the remote. When using the set as a baby sitter, the remote unit is placed at the crib and S1 is thrown to PHONE. S2 need not be operated because it is a spring-return type which remains normally in the LISTEN position.

Transistor B supply

Expensive, short-lived B batteries are the main disadvantage of portable receivers. In Grundig's model Transistor Boy L ac–battery portable they have been eliminated and replaced by a transistorized oscillator type supply operating from the 6-volt dc filament supply. Since the major portion of the B-supply drain is taken by the output tube in the average set, drain has been reduced by replacing the tube with a pair of 0C72 transistors. The audio and power supply circuits of this set are shown in Fig. 5. The set operates from a 6-volt nickel-cadmium storage battery or from the ac line through a stepdown transformer and rectifier.

The 0C76 transistor is connected in a Hartley type oscillator circuit using a part of a tapped autotransformer. The voltage developed across the oscillator section is stepped up and applied to a metallic rectifier delivering 60 volts dc at 3 to 4 ma for the converter, if and af amplifiers and driver. Design data on this and other dc converters using 0C76 transistors will be found in an application bulletin which may be obtained from Amperex Corp., Hicksville, N. Y.

The push-pull output stage is driven by a DC96 triode through transformer coupling to match the high plate load impedance to the low input impedance of the transistors. Adequate response is obtained through a frequency-sensitive feedback network from the voice coil to the driver grid.

The storage battery can be charged from the ac line by throwing the CHARGE–OPERATE switch to CHARGE and opening the ON–OFF switch. The 6- and 60-volt dc lines are regulated by Varistors.

Turret type bandswitch

Best possible performance of antenna and mixer circuits is seldom obtained in multiband receivers using conventional bandswitch and coil-bank arrangements. At these frequencies stray inductance and capacitance due to long leads and switch elements make it impossible to use optimum values of lumped circuit constants. Best performance requires short, direct leads and a minimum of stray capacitance, and it is most readily obtained with plug-in coils or coil turrets, which is of course why turrets are so popular in TV front ends.

These types of front-end construction have been used for years in the more expensive communications receivers but bandswitching turrets have just recently been adapted to general-purpose shortwave portables. Fig. 6 shows the turret type front end of the Hallicrafters model TW-1000 and Capehart 88P66BNL receivers. The design and construction of the tuner closely resembles the Standard Coil TV tuners. The tuning capacitors — corresponding to the fine-tuning control on a TV set — are on the main chassis. All coils except the broadcast antenna coil are on turret strips.

Band coverage is as follows: Band 1—1.8–3.9 mc, 2—14.62–15.7 mc, 3—17.32–18.2 mc, 4—9.22–10.3 mc, 5—3.9–8.0mc, 6—11.42–12.3 mc, 7—540–1600 kc, 8—180–400 kc. END

Receiver features high sensitivity on both broadcast and shortwave bands

TRANSISTOR SHORTWAVE REGENERATOR

By EDWIN BOHR

BUILD this transistorized shortwave regenerator and have a set that rolls in stations from every corner of the world! The detector oscillates strongly to 12 mc and operates with less sensitivity at even higher frequencies. Bandspread and bandswitching are both featured.

The set is a real "hot rod." The dial is usually crowded with hundreds of stations and, with an antenna of only 8 feet of wire on the floor, the receiver can always be counted on to pull in both European and Asian stations. Although a little more difficult to operate, it easily keeps pace with many communication receivers. The set is also a good performer in the broadcast band.

Regeneration is controlled by variable inductive coupling and is very smooth —in fact, much better than most vacuum-tube circuits I remember building. Since inductive regeneration control does not affect any of the transistor dc operating parameters, there is little, if any, interaction between regeneration and tuning controls.

The detector operates into a one-stage audio amplifier through resistance coupling. This gives somewhat better regeneration control than transformer coupling. Also, the amplifier acts as a buffer, reducing the obnoxious tendency of regenerators to vary with earphone lead position. In fact, if the set is grounded, this trouble is not noticeable.

Regeneration in the shortwave bands has heretofore been impossible with diffused-junction transistors—the familiar p-n-p type. High-frequency operation was limited to the grown-junction n-p-n transistors. By using a smaller germanium pellet, smaller indium emitter and collector dots and by lowering the base resistance, the manufacturers of p-n-p transistors are now able to manufacture 10-mc units.

One of these new transistors, the G-E 2N137, is the heart of this regenerative circuit. This transistor is now rather expensive, selling for about $6.50. The price will surely take a sharp drop when demand increases and production bugs are combed out.

Regenerator circuitry

The unit is very simple electrically. The tuning components are in the transistor collector circuit and are tapped for bandswitching (Fig. 1). Two of the windings (L1 and L2) are on a ferrite antenna rod; the third (L3) is physically separate and wound on an LS-3 type of slug-tuned coil form. Regeneration is coupled (except for slight supplementary regeneration to be discussed) only into L3.

The LS-3 coil form is a product of Cambridge Thermionic Corp. and is readily available from most mail-order radio supply houses and many radio and electronic parts distributors.

The transistor base is grounded and regenerative feedback couples to the emitter. This regenerative or tickler coil mounts to a ¼-inch plastic shaft, coupled to a knob on the front panel. As the knob is turned, the tickler coil is varied from tight to loose coupling.

Emitter bias comes from a separate bias battery through a 10,000-ohm resistor. This type of bias arrangement gives the ultimate immunity from temperature drift. Not once has retuning been necessary because of temperature changes. The detector bias-resistor value is rather critical—10,000 ohms is about optimum. For a fixed collector voltage, high-frequency performance falls off with decreasing resistance and overall gain decreases with higher values.

With the 10,000-ohm resistor, the detector pulls less than 200 microamps. All Scotsmen take notice! The total drain on the batteries, including the audio stage, is less than 1 ma.

Mercury cells power the circuit. These have a high energy-to-volume ratio, and are free from the aging

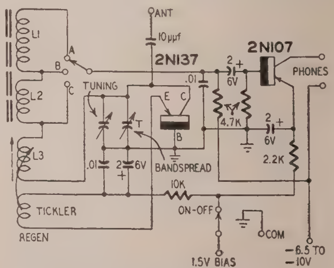
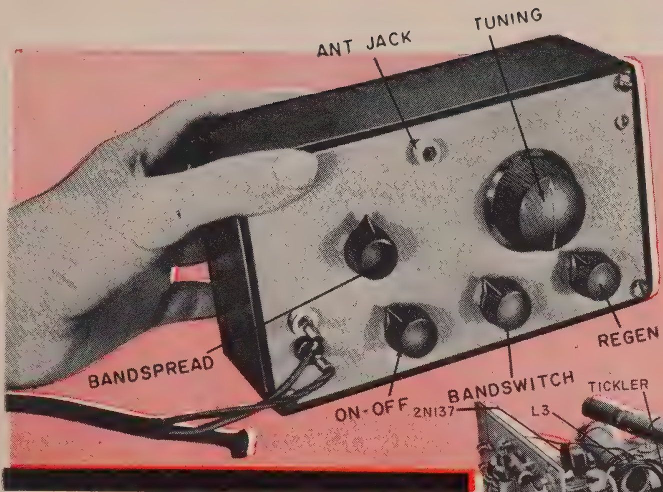
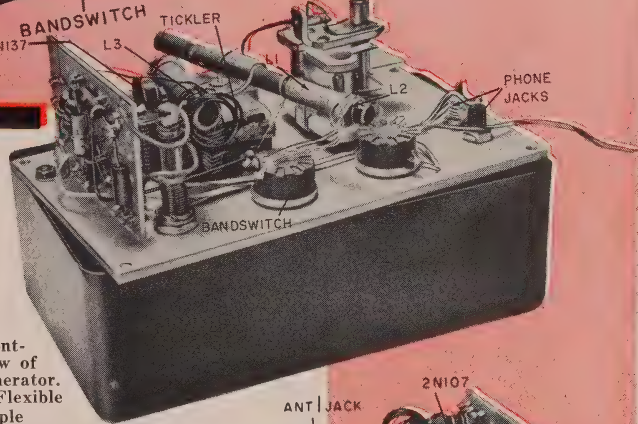
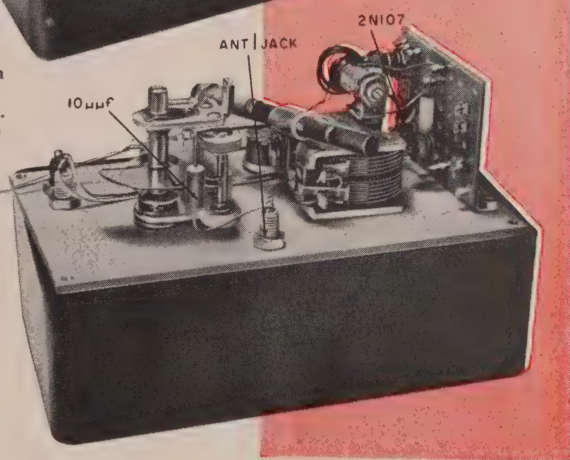


Fig. 1—Schematic diagram of the high-gain shortwave transistor regenerator.







effects common to dry cells. However, dry cells will do, but for a portable set, mercury cells are preferrable.

All detector bypassing, as indicated, should return directly to the transistor base. Because of the impedances involved, large values of rf bypass capacitance (.01 μf) are necessary. The emitter must have a low-impedance audio-frequency path to ground; this is obtained through the 2-μf electrolytic from the 10,000-ohm resistor. Because the impedance of the electrolytic begins to increase at rf, shunting the electrolytic with a .01-μf paper capacitor improves performance by keeping the impedance from rising too high.

The audio stage is conventional and uses a G-E 2N107 dollar-variety transistor. Because the circuit is well stabilized, just about any p-n-p transistor, high or low gain, can be used. No volume control is necessary. The audio stage will handle a very big signal without overload. If the volume is uncomfortably loud, turn down the regeneration or slide the earphones forward.

Top—Front-panel view of the regenerator. Center—Flexible leads couple tickler coil from Lucite shaft to insulating board. Bottom—Closeup shows layout of components.

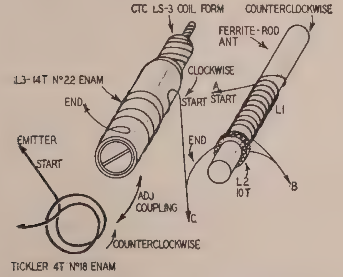
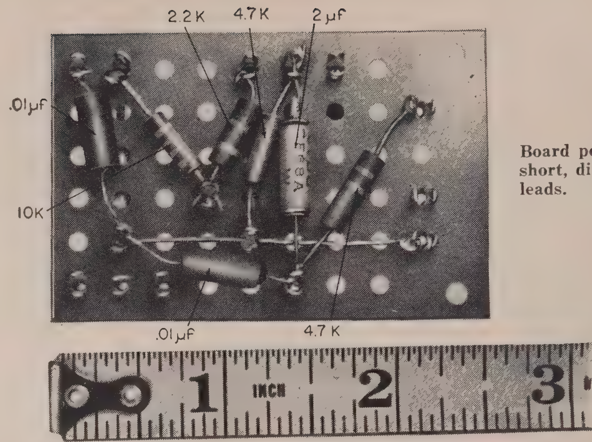


Fig. 2—Regenerator coil winding data.

The radio is turned off by interrupting the bias-battery lead. This leaves only a few microamps of collector current flowing which is no particular disadvantage.

The builder will undoubtedly wish to use an available cabinet or simply throw together a preliminary breadboard cir-



Board permits short, direct leads.

cuit. This is permissible, but the coil-winding directions should be followed. The number of turns can be changed but, we repeat, do not change the winding directions. Fig. 2 illustrates the coil-winding procedure.

Coil L1 is an MS-264 transistor loop antenna sold by Lafayette Radio with all but 55 turns removed (about one-third of the winding will remain). Coil L2 consists of 10 turns of the wire just removed and rewound jumble-style at the end of the loop. Broadcast-band operation may necessitate additional regeneration. To do this, simply swing the end of the antenna near the tickler loop (the antenna is swung *away* from the tickler in the photograph) and tighten it in place at the point of best operation.

Coil L3 is wound on a Cambridge Thermionic LS-3 coil form and mounted with a right-angle bracket to the tuning capacitor. Since the end terminals supplied with the coil would interfere with the tickler-coil movement, they cannot be used. Instead, only coil dope holds the winding in place. No. 22 enameled wire is used.

The tickler (Fig. 3) is self-supporting from a Lucite shaft. Small holes are drilled in the shaft and the coil wires heated slightly and pushed through the holes. Stranded, flexible wire connects the tickler to the transistor chassis. The tickler is wound with No. 18 enameled wire and has an inside diameter of ½ inch. The turns are spaced slightly.

Rotating the Lucite shaft controls regeneration by varying the coupling between L3 and the tickler. The shaft is supported in a universal panel bearing (ICA 1250 or equivalent). A compression spring and C-washer provide the friction loading needed to maintain the tickler adjustment. The control knob is pulled snugly against the front of the panel bearing and serves as a thrust bearing.

The tuning capacitor is one of the new transistor circuit types (Lafayette MS-261). For use in this circuit, both the antenna and oscillator sections are tied together. Yet, even then, because of the shunt capacitance present, only approximately a 2-to-1 range can be covered. A 3-to-1 range can be covered, however, by using a conventional 365- or 410-$\mu\mu$f tuning capacitor. This will allow the broadcast band to be covered with no coil changes from the specified data.

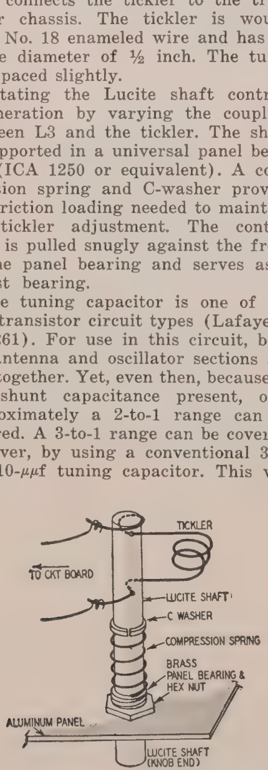


Fig. 3—Tickler unit construction.

As is, the tuning ranges are: position A, 800–1600 kc; B, 3.8–6.5 mc; C, 6–13 mc. The value of the bandspread capacitor is not critical. Any variable capacitor with a maximum capacitance of from 15 to 35 $\mu\mu$f should do. The thick population of shortwave stations across the dial makes bandspread a necessity.

All transistors, bypass capacitors and resistors are mounted on a small insulating board for short leads and compact wiring. The electrolytics are conventional types reduced in size and adapted for transistor circuitry. These new electrolytics all have the leads brought out through tiny rubber bushings. Consequently, on many types the leads are extremely delicate and easily broken. Despite great care, several have been ruined. The type specified in the parts list, however, is among the most rugged tested and none have broken as yet.

Operation

A nominal bias voltage of 1.5 is specified. A single mercury cell delivers less voltage than this but is satisfactory. The collector voltage should be 6.5 (five mercury cells or one mercury battery) to 10 volts; 10 volts is the maximum that should be used. By using 10 volts, the set's range of oscillation is extended 1 mc higher. Magnetic earphones with an impedance from 2,000 to 10,000 ohms are satisfactory. Loud signals can be heard several feet away from the headphones.

Regeneration is usually indicated by a soft frying or hissing sound. As the dial is rotated toward the high end of the dial, the regeneration must be advanced to maintain proper operation. Too much regeneration produces a loud howl or putt-putt sound. Regeneration seems to be more easily adjustable on shortwave bands than in the broadcast band. Also, experience will show that optimum regeneration depends to a great extent upon signal strength.

If the set does not regenerate, very probably either the tickler or L3 is connected backward. The 2N137 collector voltage should measure approximately 1 volt less than the supply voltage and there should be a very small positive voltage from the emitter to ground, just enough to move the pointer on a low scale.

The antenna couples to the set through a 10-$\mu\mu$f capacitor to the collector. Alternately, the antenna may be connected directly to the 2N137 emitter. This is better for long antennas. If the radio is grounded, the circuit is more stable. But either a shorter antenna should be used or its connection moved to the emitter. Otherwise, the circuit may be loaded too heavily and will not regenerate nor go into oscillation.

The experimenter, by using plug-in coils and other tuning arrangements, can probably push the operation of this circuit to still higher frequencies. This circuit certainly is a good starting point for anyone interested in high-frequency transistor operation. Nevertheless, it is also equally good as a finished design for anyone wishing a small portable radio. The ruggedness and low power drain of the transistor make the circuit attractive for emergency or disaster use. END

Parts for transistor regenerator

1—2,200, 2—4,700, 1—10,000 ohms, resistors, ½ watt; 1—10-$\mu\mu$f ceramic capacitor; 2—.01-μf 200-volt capacitors (Aerovox P832 or equivalent); 3—2-μf 6-volt capacitors (Barco PT 6-2 or equivalent); 1—tuning capacitor, miniature 2-gang, both sections tied together (Lafayette MS-261 or equivalent); 1—trimmer capacitor (see text); 1—2N137; 1—2N107; 1—loop antenna (Lafayette MS-264); 1—coil form (Cambridge Thermionic LS-3); 1—1-pole 3-position switch; 1—spst switch; mercury cells; 3—pin jacks; 1—4-inch plastic rod, ¼-inch diameter; 1—¼-inch bearing for ¼-inch shaft (bearing from discarded volume control will do); 1—cabinet; 1—panel; 1—length of No. 18 and No. 22 enameled wire; 1—insulating-board transistor chassis; 5—knobs.

JUNCTION TRANSISTOR TRIGGER CIRCUITS

Apply vacuum-tube analogy to the study of transistorized trigger networks

By STAN SCHENKERMAN

TRIGGER circuits are an indispensable part of modern electronics. We find them not only in such complex equipment as radar sets and digital computers, but also in the "ordinary" devices that the radio and television technician is and will be called upon to service—black-and-white and color television, the multiplex radio sets of tomorrow and many others which are as yet still in the dreams of design engineers.

The transistor is having a profound influence on such developments and thus transistor trigger circuits are of prime interest. Investigations have almost exclusively aimed at the point-contact type in the past, because of its inherent negative resistance. Progress was less encouraging than anticipated and research is now being directed almost entirely toward the several types of junction transistor.

Junction types hold more promise for several reasons: They are more rugged and reliable than point contacts and, due to current manufacturing emphasis, are readily available. Junction circuits can be designed by analogy with conventional tube circuits; the tried and proved techniques of vacuum-tube practice can be almost painlessly carried over to transistors.

We will discuss three trigger circuits developed by the analogy method. Each has different applications: the bistable multivibrator is a gating device, the one-shot multivibrator produces a gate of variable duration, the blocking oscillator generates short pulses. We used 2N98 n-p-n junction transistors because the high collector supply voltage and high pulse output with good rise- and decay-time characteristics are particularly suited for these and similar switching circuits. Thus the figures all show n-p-n rather than the more common p-n-p circuits.

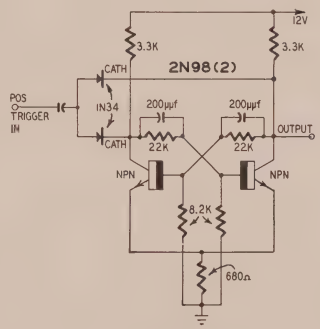


Fig. 2—The bistable multivibrator.

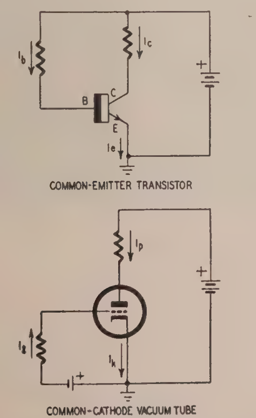


Fig. 1—Diagrams show the basic vacuum-tube and transistor circuits.

Junction-transistor–tube analogy

Before getting into actual circuitry, let's discuss the principle of analogy. Fig. 1* shows a junction transistor and a vacuum-tube triode in common-emitter and common-cathode connections. The symbols e, c and b represent the emitter, collector and base, respectively.

We can immediately draw an analogy between the terminals of the two devices: The emitter corresponds to the cathode, the collector to the plate, the base to the grid. The analogy may be extended by noting that an ac signal undergoes a phase reversal between input and output electrodes—base and collector for the transistor, grid and plate for the tube.

There are, of course, certain differences between the two. Whereas the grid is returned to a negative source and I_g is zero for normal operation, the base return is positive (in transistors with a positive collector) and I_b is not zero. This means that the input resistance of the transistor is not infinite, as is the tube's, but has a finite, actually low, value.

The magnitudes of the output resistances are also dissimilar, the transistors' being much higher than that of the tube. However, as alpha, the ratio of a change in I_c to a change in I_e, increases to unity, the differences decrease and the analogy becomes closer. The input resistance of the transistor rises and its output resistance drops correspondingly.

An important difference that does not change with alpha is the input voltage at which conduction begins. For the tube, the grid–cathode voltage must be more positive than the cutoff level. The transistor, however, conducts only

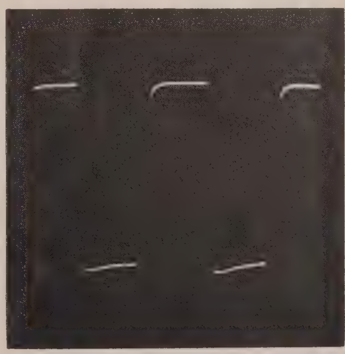


Fig. 3—Output waveform of bistable multivibrator at 100 kc, 10 volts p-p.

*All diagrams and photos courtesy *Transistor Research Bulletin*

for a base–emitter voltage equal to, or greater than, zero; it is cut off for *all* negative values.

Thus, to transistorize a vacuum-tube circuit by analogy, we must make use of the similarities of the two devices and use transistors with alphas close to unity to minimize the differences. The operating principles of the resulting circuits are the same as for their tube counterparts.

Bistable multivibrator

The transistor version of the popular bistable multivibrator is shown in Fig. 2. Feedback is provided by the dc coupling from collector to base, through the voltage divider (the 22,000- and 8,200-ohm resistors) and through the 680-ohm common-emitter resistor. This differs slightly from the usual tube circuit where the common-cathode resistor is omitted and the shunt arms of the divider are returned to a negative voltage. Actually, the 680-ohm resistor, in addition to biasing the *off* transistor beyond cutoff, stabilizes the *on* transistor and aids the start of regeneration whenever a trigger pulse is received.

The 200-$\mu\mu$f speedup capacitors allow rapid changes, such as trigger pulses, at the collectors to be coupled immediately to the opposite base and, therefore, also help start the switching action. Their values are determined experimentally.

Although the triggers are shown applied through the isolating diodes, to the collectors, other points could have been chosen.

The output waveform of the device is shown in Fig. 3. The peak-to-peak amplitude is approximately 10 volts and the repetition rate 100 kc. This does not represent the maximum frequency at which the circuit will operate. The photograph, as are all photographs in this article, was taken while the circuit was still on a breadboard, where no particular attention was given to circuit dress.

One-shot multivibrator

The emitter-coupled circuit shown in Fig. 4 is derived from the cathode-coupled tube version. There are two advantages of this over other types of one-shot multivibrators—it is highly stabilized by the common-emitter resistor; the width of its output pulse can be easily controlled by varying the setting of the 1,000-ohm potentiometer. Stabilization is obtained by the negative feedback produced by the 680-ohm resistor when the circuit is not in transition (switching states). Control of the pulse duration is not quite so obvious:

In the stable state V2 is *on* because its base return, through the 68,000-ohm resistor, is positive. When a negative trigger is applied, through the isolating diode and the 50-$\mu\mu$f coupling capacitor, the circuit switches to its quasi-stable state—V1 *on* and V2 *off*.

At the end of the transition, the timing action begins as the capacitor charges. This causes the base of V2, which has been driven negative, to rise toward the 13-volt supply. This rise continues as long as V2 is off, i.e., until the base attains the emitter voltage. But the emitter voltage is developed across the common-emitter resistor and is equal to the difference between E and the base–emitter drop of V1, the *on* transistor. For all practical purposes, the base–emitter drop of a conducting transistor is zero. Thus, the voltage of the emitter of V2 is E. The base, therefore, rises until it reaches E volts, at which time the circuit flips back to its original state. Thus, the duration of the output pulse is determined by the magnitude of E and can be varied by changing the potentiometer setting.

This is demonstrated in Fig. 5 which shows the output waveform at two values of E. For each, the amplitude is approximately 10 volts peak to peak and the triggering rate is in the order of 100 kc.

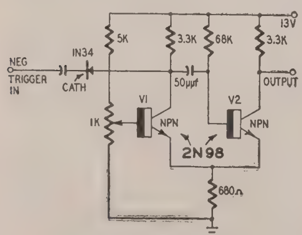


Fig. 4—The one-shot multivibrator.

Fig. 5—Output waveform of one-shot multivibrator at 100 kc, 10 volts p-p.

Blocking oscillator

The transistorized version of this familiar circuit, as shown in Fig. 6, is free-running. The time between pulses is controlled by changing the setting of the variable resistor or the value of the 2.5-volt source. This can be seen by considering the timing process.

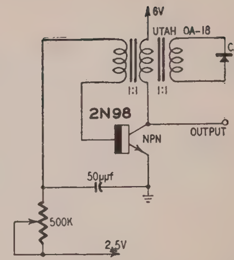


Fig. 6—The basic blocking oscillator.

During the pulse, the capacitor charges. The charge, after the pulse has terminated, biases the transistor beyond cutoff. As the capacitor now discharges through the variable resistor, the base rises toward 2.5 volts. When it reaches zero, the transistor conducts and another pulse is generated. The off period is thus determined by the slope of the discharge curve, which in turn is a function of the capacitor, the variable resistor and the 2.5-volt power supply source.

Fig. 7 shows the 6-volt output pulse at a repetition rate of 60 kc, having a duration of 2.5 μsec. Ringing is prevented by the damper diode across the transformer tertiary, which acts to short out the positive excursion of the oscillation.

The waveform is remarkably free from jitter as compared with a tube blocking oscillator. Jitter is caused by fluctuations in the conducting potential. The transistor conducts at zero base–emitter volt and the total variation of its conducting potential is very small. However, the cutoff level of a vacuum tube may readily change by large amounts.

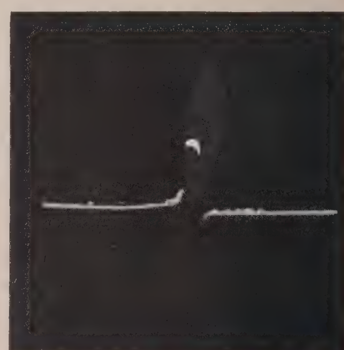
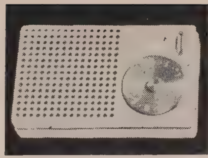


Fig. 7—Output waveform of blocking oscillator at 60 kc, 2.5-μsec duration.

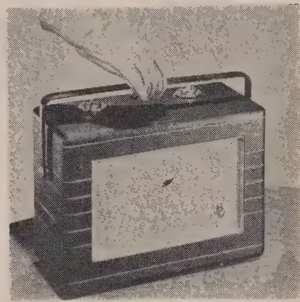
The principle of analogy provides us with a powerful method of design. We can directly transistorize tube circuits. It is especially applicable to trigger circuits and brings us that much closer to the time when the technician will be servicing transistor radios and television sets daily. END



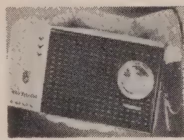
Regency's TR-1, a pioneer in the field of all-transistor radios—weighs less than 12 ounces.

TRANSISTOR RADIOS

Part III—Transistor superhets; circuit considerations; biasing; feedback; the Regency model TR-1



Raytheon model T-2500—transistorized twin-speaker radio receiver. First of the larger transistor sets.



Raytheon T-150 — contains 6 transistors and weighs only 22 ounces

By I. QUEEN
EDITORIAL ASSOCIATE

TRANSISTOR superhets have much in common with the older tube sets. They both have the same local oscillator, first and second detectors, one or more if stages and so on. The basic principles relating to such things as amplification, oscillation and coupling remain similar. Therefore, a radio technician does not have to start from scratch to understand and repair transistor sets. It is simply a matter of extending present knowledge to take into account the peculiarities and characteristics of transistor circuits.

Certain basic principles of transistors were presented in Parts I and II. It was stated that the transistor emitter is considered as the source of charged particles. Thus, the emitter acts like a cathode. In a p-n-p unit, the emitter is connected to the positive terminal of a battery which injects positive charges (holes) into the semiconductor where they come under the influence and control of the base. As the base is made more *negative*, the flow of positive charges increases. The base itself absorbs only a small percentage of the total holes. The remainder are attracted by the negative collector, doing useful work when they enter the output load. Thus the base is like a grid; the collector like a plate.

In an n-p-n transistor the power supply must be reversed. The negative battery terminal injects electrons (negative particles) into the semiconductor. These are attracted by the positive collector. Flow increases when the base goes more *positive*.

The important facts to remember are: In a p-n-p transistor conduction and gain increase when the base goes more negative or the emitter more positive. In an n-p-n unit, the same results are obtained when the base goes more positive or the emitter more negative.

Most transistor amplifiers, both if and af, are connected in grounded-emitter fashion. The base and emitter form the input elements; the collector and emitter the output. This, of course, corresponds to a conventional grounded-cathode circuit and provides maximum power gain. A resistor is often included in the emitter lead. This, like the corresponding cathode resistor, leads to negative feedback if unbypassed. In a transistor circuit, there is an added function. The resistor stabilizes against temperature effects. If the ambient temperature rises, the semiconductor tends to pass more current. Since this automatically increases emitter bias, the tendency is compensated immediately. Temperature may greatly affect transistor performance.

While an emitter resistor is desirable for its stabilizing effects, it also biases the transistor and sometimes creates problems. For example, a 10,000-ohm emitter resistor will produce a 10-volt drop if the transistor passes 1 ma. This bias is far too large since the usual base–emitter potential difference should not exceed a small fraction of a volt. The problem is solved by placing bias on the base as well. It is like a tube circuit with a large cathode resistor which leaves the cathode at a high voltage above ground. The remedy is to bias the grid until the grid–cathode potential is as required. For this reason many transistor circuits have both the base and emitter biased. The bias on each element may be obtained from a resistor in series with a battery, from a voltage divider or some other way.

While discussing bias, note that a transistor is nearly cut off when its bias is zero. Compare this with most tubes which conduct, perhaps heavily, at zero bias. For class-A amplification, a transistor requires *forward* bias so that it may conduct at all times.

A tube amplifies voltage; a transistor amplifies power. Therefore, it is important to match impedances at the input and output of each stage. Transformers are suitable for this purpose. The input (base–emitter) circuit requires about 600 ohms for optimum matching. The output (collector–emitter) requires about 25,000 ohms. Therefore, coupling transformers (both if and af) are stepdown types. Since transistors are power devices a ferrite-rod antenna cannot provide any gain by itself. A coil can step up voltage but cannot amplify power. A ferrite-rod antenna for use with transistors must be as large as possible (for maximum pickup), with high Q and a suitable impedance to match the transistor input circuit.

Automatic gain control need not be discussed here since it follows conventional tube principles. But neutralization is an important topic. Neutralization, never required in modern tube superhets, is generally used in transistor sets.

Conventional transistors are triodes, and a triode cannot shield its output element from the input element. Even though a transistor is tiny, it has con-

siderable collector–base capacitance—enough to couple these elements and feed back energy. Younger technicians may not remember, but in earlier days of radio (before the introduction of the screen grid) broadcast receivers were neutralized.

To counteract the feedback between transistor elements, energy is deliberately fed back from output to input *out of phase* with the interelectrode energy. Fig. 1 shows such a neutralizing scheme recommended for the Sylvania n-p-n types 2N94 and 2N94A. A 10-$\mu\mu$f neutralizing capacitor couples the collector and base. The voltage through this small capacitor is out of phase with the voltage feeding directly through the transistor capacitance. This is evident since the voltages are taken from opposite ends of the same winding. If the tap is at the center of the coil, the neutralizing capacitance equals the collector-base capacitance.

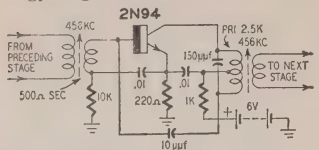


Fig. 1—Schematic shows a simple feedback setup from collector to base.

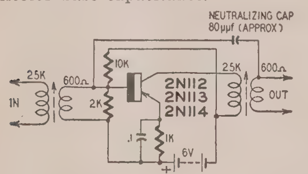


Fig. 2—Secondary energy fed back.

A second method, shown in Fig. 2, is recommended for Raytheon p-n-p types 2N112 through 2N114. The neutralizing voltage is taken from the secondary which reverses polarity as required. The greater the stepdown ratio of this transformer, the smaller the voltage available for neutralization, so the larger the capacitor needed. Approximately, the neutralizing capacitance must equal the collector–base capacitance times the stepdown ratio.

Regency model TR-1

This transistor superhet, the first of its kind, was introduced over a year ago. It measures only 3 x 5 x 1½ inches and weighs only 12 ounces, so it can fit a shirt pocket. All transistors are Texas Instruments n-p-n types. A 262-kc if was chosen for higher gain. The gain of a transistor drops with increasing frequency.

The Regency diagram appears in Fig. 3. The first stage is a combined oscillator–converter. Oscillation results from coupling between emitter and collector coils. Note the resemblance to a tickler arrangement in a tube oscillator. The emitter tank is tapped down to match the low impedance of this element and to reduce damping. The antenna is a flat ferrite rod, somewhat larger than a conventional tube type. Its secondary, untuned and of low impedance, couples the rf into the base, giving minimum antenna loading and optimum impedance matching. This stage is decoupled from the battery by a 2,200-ohm resistor and a .001-μf capacitor.

The next two transistors are high-gain if types. Like all transistors in this set, they are n-p-n types and require a positive collector and negative emitter. They are neutralized by capacitance and resistance. This takes account of the fact that feedback through the semiconductor can take place through resistance as well as capacitance. A tube circuit never uses resistance neutralization because the extremely high resistance between grid and plate permits no coupling between these elements.

The detector is a diode which produces a negative drop across the 1,000-ohm volume control. This *negative* voltage is taken from the top of the volume control and fed through 2,700 ohms to the base of the first if amplifier. It was pointed out earlier that a negative base tends to reduce gain in an n-p-n type. The stronger the signal tuned in, the greater the negative voltage at the anode of the diode. This control signal reduces if gain, as required, for effective agc.

The af component flows through a large capacitor to the base of the output transistor. The dc component of the rectified signal is blocked. This transistor has a gain of about 39 db and can handle up to 12 mw at 6% distortion. This is sufficient for most personal listening.

Bias networks

This analysis may be applied to other transistor receivers and is especially important where normal voltage readings are not listed in the schematics on hand.

Remember these facts: The potential difference between emitter and base of a transistor is very small; in a class-A amplifier it may be approximately 0.2 volt, in a detector perhaps nearly zero. The transistor is biased in the forward direction. (For example, in an n-p-n unit, the base is more positive than the emitter.) Emitter and collector currents are nearly equal. Normal transistor currents are approximately 1 ma or less (except in power types). For example, the TI223 and TI 222 require about 0.7 ma and the TI210 requires about 2 ma through the emitter and collector.

The converter stage of the Regency set is both emitter- and base-biased. The emitter is about 7 volts positive (with respect to chassis), therefore the voltage drop across the base resistor will be about 15.5 for practically zero bias between base and emitter. The collector will be about 21 volts, positive, due to the drop across the decoupling resistor. (In the previous calculations we have assumed a normal transistor current of 0.7 ma through the TI223.)

The first if stage is also both emitter- and base-biased. The emitter stabilizing resistor will produce a drop of less than 0.5 volt. This is balanced by a nearly equal voltage on the base, provided by a voltage divider composed of a 100,000-, a 2,700- and a 1,000-ohm (volume control) resistor. A simple Ohm's law calculation will prove that the base is also about 0.5 volt positive.

The voltage on the base is also controlled by the rectified rf across the volume control. At full signal, a *negative* control signal is fed to the base so its voltage drops to about 0.1. Naturally, emitter current is also reduced since this element must have even lower voltage than the base.

The base bias of the second if stage is *fixed*, being applied by the emitter of the output stage, which is about 2 volts positive. The emitter of the second if stage is also about 2 volts positive, assuming 0.7 ma flowing through the 2,700-ohm stabilizing resistor. This stage has a larger stabilizing resistor than the first if because it is not gain-controlled.

The final stage has about 2 volts on its emitter, due to the drop across the stabilizing resistor. The base is fed from a voltage divider across the battery. With the nearly 9-to-1 ratio of the divider, we can estimate approximately 2 volts on the base also.

Several factors contribute to the tiny size of this portable: it uses a printed circuit; the battery is a size-U type which is very small and light; the dual variable capacitor is only about 1 inch deep; the speaker is a Jensen P-275Y, only 2¾ inches in diameter and with a nearly flat cone.

Part IV will discuss more recent transistor superhets which use an if of 455 kc. TO BE CONTINUED

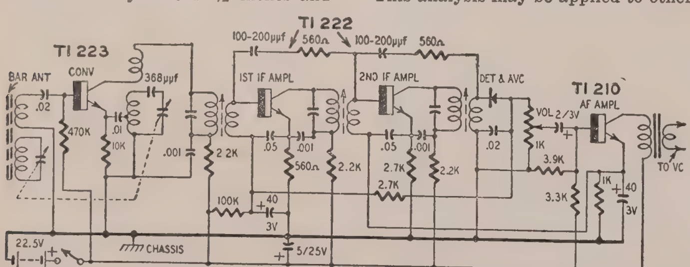
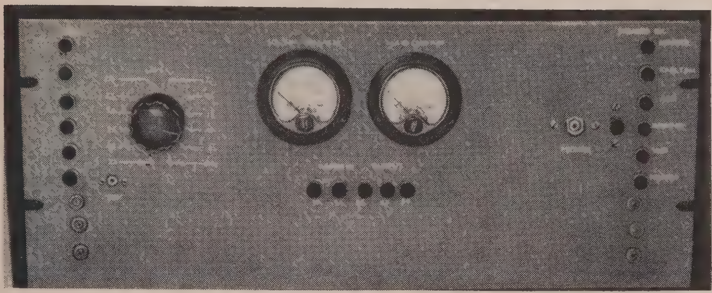


Fig. 3—Schematic of the Regency all-transistor superheterodyne receiver.

The Laboratory GOLDEN EAR



The Laboratory Golden Ear. Photo shows panel view of amplifier during early stages of development. Meters and terminals were later eliminated.

Part I—High-fidelity high-power amplifier may be built as complete unit, or its circuits and ideas applied to existing equipment

By JOSEPH MARSHALL

JUST what should the practical specification limits be for an amplifier intended for home listening? Most authorities will agree that if an amplifier delivers 10 watts over the audible range from 20–20,000 cycles with intermodulation distortion not over 2% and has good transient response and transient stability, it will satisfy almost any home listening need. A few supercritical listeners demand a closer approximation of the ideal. Moreover, the experimenter often needs—for measuring and testing such critical operations as recording and broadcasting, and in high-level high-fidelity systems for auditoriums, theaters, etc.—an amplifier with high power output and the least possible influence on the signal fed into it. The Laboratory Golden Ear amplifier will be of interest for these special situations.

The Laboratory Golden Ear (see photo) can be used with either four KT66's for an output of over 50 watts or two of the tubes can be removed at any time for an output of around 30 watts (Fig. 1). With a pair of tubes the output at the clipping point is 28 watts and with four it is capable of a little over 50 watts. (The distortion figures are for a resistive load.) The curves do not represent the best possible; they should be duplicated readily and can be surpassed with a fortunate combination of tubes.

It was not possible to run frequency curves below 15 or above 30,000 cycles for lack of a suitable generator but the square waves (Fig. 2) indicate that, except for a small peak somewhere between 100 and 150 kc, the curve at low levels should be very flat from approximately 2 to 300,000 cycles.

There is a barely visible trace of ringing on a 30-kc square wave with a resistive load; the ringing increases slightly when the load is removed. But even with a reactive load as high as 0.1 μf the ringing never approaches an unstable level either at maximum output or low levels.

Fig. 3 shows the shape of a triggered low-frequency step transient (keyed 1.5 volts dc). Switching thumps produce a similar trace. Fig. 4 shows the IM distortion characteristic with two and four KT66's in the output circuit.

The curves and traces indicate that at up to about 80% of maximum output the amplifier will have no significant effect on any waveform in the audible spectrum, no matter how complex, irregular or transient it is. Moreover, the amplifier is almost incapable of generating any significant transients. The character of the output waveform and of the sound will depend entirely on the signal fed into it and the loudspeakers fed by it. More than this an amplifier cannot do.

The circuit is a modified form of the Golden Ear configuration used in other amplifiers described in RADIO-ELECTRONICS and other periodicals. It consists of a cross-coupled inverter feeding a direct-coupled driver; this is R-C-coupled to a cathode-follower driver, direct-coupled to the output tubes which operate Ultra-Linear. There are some small but significant differences from past versions.

Amplifier circuit

Readers familiar with the Golden Ear will note that the parameters of the cross-coupled inverter (Fig. 5) are different. I discovered early in my experiments with this inverter that

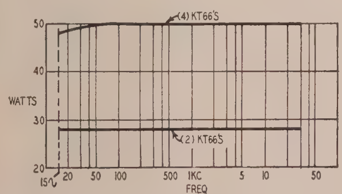


Fig. 1—Power response curves at clipping point using two or four KT66's.

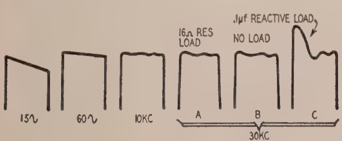


Fig. 2—Square-wave response at various frequencies—under different loads.

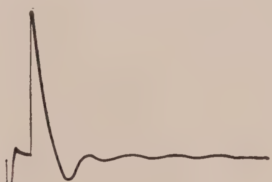


Fig. 3—Keyed step-transient response.

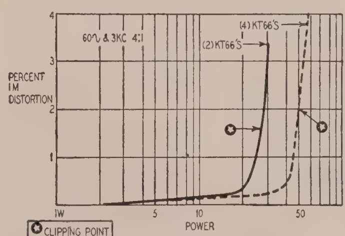


Fig. 4—Intermodulation characteristics.

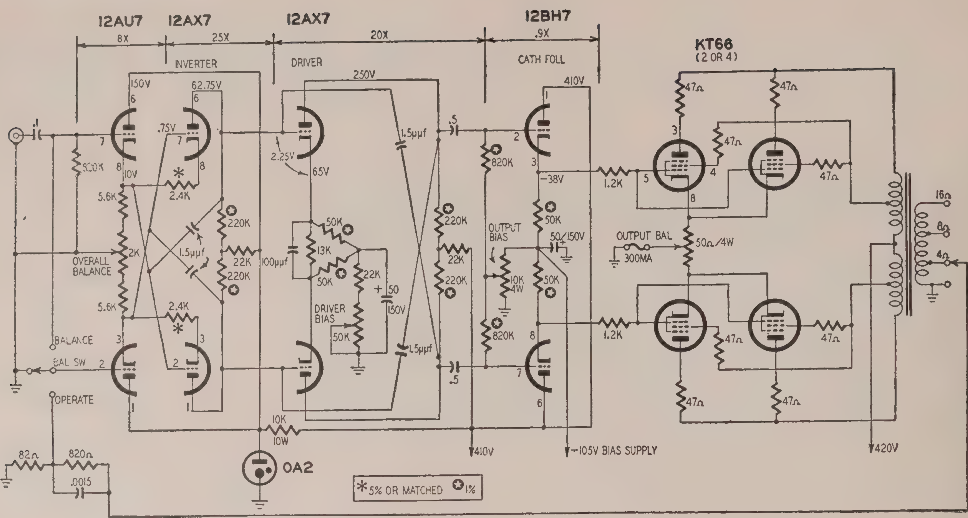


Fig. 5—Schematic diagram of the Laboratory Golden Ear—less power supply.

there was a limit to the improvement in lowered distortion which could be produced by increased feedback; others noted the fact also. A number of experimenters, notably David Hafler, studied the inverter to find the fault. It turned out to lie in the input cathode follower, which as originally developed by Van Scoyoc used cathode loads of about 3,000 ohms. With this load, the tube could not handle inputs greater than 1 volt. Thus, when feedback was increased to a point requiring greater drive, distortion would rise markedly.

In this amplifier the input tubes use cathode loads of about 7,000 ohms. Whether this is the optimum load is not yet determined, but in this particular case it gives considerably improved results. The cathode resistors of the inverter section have also been increased from 1,200 to 2,400 ohms; though this makes less difference it does seem to provide better results. The inverter operates with 150 volts of plate supply from a voltage-regulator tube which not only provides stabilization but also the decoupling largely responsible for the excellent transient stability.

The driver is a direct-coupled 12AX7 using the bridge type current feedback of earlier versions. The resistor from cathode to cathode controls the current feedback and is chosen to provide slightly less than 10 db. The net gain of the stage within the audio range is about 20. However, there is also a reactive shunt in the form of the 100-$\mu\mu$f capacitor which reduces degeneration beyond 50 kc and thus increases gain above that point. This and the neutralization applied to both the inverter and driver result in the very flat high-frequency response. Neutralization of the inverter does not have appreciable effect on the frequency response, but its effect on phase is sufficient to make the high-end stability much better when the overall feedback is applied. Together with the phase-shifting capacitor across the feedback resistor in the voltage feedback loop, it accounts for the remarkable 30-kc square waves and freedom from ringing.

A bias potentiometer is included in the cathode leg of the driver. The optimum bias is -2.25 volts. I suggest the use of the 50,000-ohm pot and 22,000-ohm resistor in series, as shown, rather than a single 75,000-ohm pot; with this arrangement there is higher insurance against accidental positive biasing.

Many people wonder about the stability of a direct-coupled section using a high-mu, low-bias tube as the final element. The answer is that, if matched resistors and tubes are used, the stability approaches that of average R-C-coupled stages. A number of stabilizing elements are built into the design: Although the current feedback to a push-pull signal is only about 10 db, the feedback to any out-of-balance components is more than 20 db, due to the 50,000-ohm cathode resistors. These resistors also help stabilize bias. Throughout the push-pull stages 1% resistors are used. Since ½-watt deposited carbon types (IRC Precistors and Aerovox Carbofilm) are now available at about 40 cents and since only 10 are needed, the use of these increases the cost over 5% carbon resistors by only some $2 and the improvement in stability and distortion level is considerably greater. Any unbalance due to differences in tubes can be taken up with the overall balancing pot as we shall see.

Each direct-coupled section has balancing elements. The inverter is fed by a regulated supply and the second section has a common series plate resistor which in this instance also improves balance. The driver has three balancing elements: the common portion of the cathode resistor; the resistor shunting the cathodes; the common plate resistor. Finally, the power supply uses a reactor input which improves the regulation of the plate-supply voltage. The combination produces fully acceptable stability. When instability occurs, it is almost always the result of a badly matched or unstable twin-triode, especially the input 12AU7.

If the highest possible stability is desired or if the line-voltage fluctuations are extreme, the front end can be made extremely stable by adding another 0A2 voltage-regulator tube in series with the present one and feeding 300 volts regulated to the driver stage and 150 volts to the inverter. The modification is shown in Fig. 6. In that case the pot in the driver cathode circuit should be 75,000 instead of 50,000 ohms.

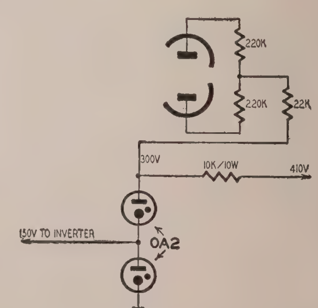


Fig. 6—Improving voltage stability.

More than 100 volts peak per side is available at the cathodes of the cathode-follower driver, with not over 3 or 4% distortion, before cancellation in the common output tube load and before overall feedback. This very low distortion is principally the result of the current feedback in the driver.

The output stage operates with fixed bias. This is the principal reason for the extremely low final distortion, especially at low volume levels. Bias is supplied by an independent supply using a reversed filament transformer or a small 125–150-volt power transformer stabilized with another VR tube. The stabilization produces a slight overbias when line voltage falls but it maintains excellent linearity at high levels and minimizes hum.

The output tubes operate Ultra-Linear with an Acrosound TO-330 output transformer. With a plate-to-plate load of from 1,600–2,000 ohms four KT66's ought to deliver about 60 watts. However, 50 watts is sufficient for almost any purpose. Peak outputs of 100 watts or more are easily available and, since the clipping is clean and symmetrical, overloads are not objectionable. Operation is held very close to class A even at maximum output.

A small pot in the common cathode circuit permits taking up the residual unbalance of output tubes. There is a 300-ma fuse in series with the cathodes and ground. Should the bias supply fail, the fuse will blow, removing plate current. Total cathode current can be read by removing the fuse and connecting a milliammeter from ground to the upper fuse terminal. The prototype has a built-in milliammeter but though useful for experimental purposes it is not essential.

To obtain optimum distortion figures the KT66's should be well matched. Emitron KT66's are now available in closely matched pairs. They cost about $1 more each but are well worth the extra cost if lowest distortion is desired. True, the output balancing control permits adjustment of small imbalances; however, the adjustment is always made at the expense of misadjusting the curve of one or both tubes. The distortion curves (Fig. 4) were taken with matched pairs. The difference is largely in linearity of the distortion curve; unmatched tubes can be adjusted to give equally good figures at either the low- or high-level end. But if adjusted for minimum distortion at 5 or 10 watts, the distortion at maximum output will be higher and vice versa.

KT66's are so far the optimum tubes distortionwise, especially at low levels. They clearly have a more linear curve than other tetrodes. Of the American types the 1614's were at least as good as any others and random pairs were more closely matched. The circuit, however, is adaptable for almost any output tubes. The new Tung-Sol 6550's will provide more than 50 watts and the TO-330 furnishes an excellent load for them. The only change needed would be an increase in bias to about −45 volts.

With appropriate power supply and output transformers 6146's would deliver nearly 100 watts. Triode operation may be used and in the parts list I recommend transformers for this mode of operation. However, unless the triodes are neutralized, they cannot be expected to produce quite so good a high-frequency response. Use 6.8-$\mu\mu$f capacitors for each tube—Centralab type TCZ or Erie NPO will do nicely with KT66's. With triode operation, the feedback resistor should be halved; triodes have only half the gain.

I know of no equivalent for the TO-330 transformer for this application. I understand that the Partridge T/CFB, more readily available abroad, is adaptable to KT66's in Ultra-Linear, but I have not tried it.

Because of the type of cathode-follower driver used, the bias can be adjusted in the range from 15–65 volts. Thus, just about any output tubes can be used. Higher bias could be obtained by increasing the bias supply voltage to 150 or more.

Feedback

The Laboratory Golden Ear uses a single voltage feedback loop around the entire amplifier, adjusted to give between 18 and 20 db of feedback. (Previous Golden Ears used an inner voltage feedback loop to insure low-frequency stability.) No other voltage loop is used because in this instance no other is needed.

This particular transformer in this particular circuit requires no phase-shift compensation at the low-frequency end. In fact, well in excess of 30 db of feedback is needed to produce motorboating. The problem was to minimize ringing at the high end. This is done, in part, by the degenerative loop in the driver and finally by the phase-shifting capacitor in the outer feedback loop. With 20 db of feedback there is a safety factor of 10 db against instability at either end. Any further increase in feedback reduces distortion insignificantly and makes the ringing much worse. (There is a considerable amount of feedback within the loop. The drivers have the current feedback already mentioned. The inverter has 6 db of current feedback and, of course, the cathode followers have large amounts, too.)

There is one justification for higher feedback—increased damping. Actually, modern speakers require less damping than formerly and with most high-quality speakers the damping provided by the single loop will produce excellent results.

The second part of this article will describe the construction and adjustment of the Laboratory Golden Ear amplifier, as far as that can be done in the case of an ever-changing, perfection-seeking piece of equipment like this one. TO BE CONTINUED

ARE ELECTRONS *FAST* or SLOW?

HOW fast do electrons travel in No. 20 copper wire when the current is 1 ampere? If you aren't sure, make a guess. Then compare your guess with the answer arrived at below:

1. By definition, 1 ampere is the rate of flow of 1 coulomb per second.

2. By definition, 1 coulomb is a quantity of electricity equal to 6,280,000,000,000,000,000 free electrons. To have current of 1 ampere that many electrons move past a point every second.

3. Suppose there is an average of 1 free electron per atom in the metals used as a conductor and that there are 610,200,000,000,000,000,000 atoms in a cubic inch of the metal. Dividing this number by the number of electrons per coulomb gives 97.17 coulombs per cubic inch of metal, in the form of free electrons.

4. A linear inch of No. 20 wire has a volume of .0008023 cubic inch. Multiplying this by coulombs per cubic inch shows that we have .07914 coulomb per inch of wire. Then, dividing 1 by .07914, we find that 12⅝ inches of wire contains 1 coulomb of free electrons.

5. If we force the electrons in the wire to travel 12⅝ inches per second, 1 coulomb of electricity will pass a given point in 1 second and current will be 1 ampere. This is an electron speed of about ¾ mile per hour. Your normal walking gait is more than four times as fast as the speed of electrons in the wire, even with a current so great as 1 ampere.

Next question: How fast does an electron travel from cathode to plate in a vacuum tube? If we had a vacuum tube big enough to have New York City at the center and Los Angeles at one side—and if potential at Los Angeles were 180 volts more positive than at New York—*and* if an electron started from rest in New York, it would arrive in Los Angeles in 1 second.

In a real vacuum tube—such as a pentode suitable for an if amplifier—the distance from cathode to plate may be 1/5 inch. If we make the plate positive by 180 volts, an electron starting from rest at the cathode will land on the plate in 1/800 microsecond.—*H. P. Manly*

? Questions about Cross Overs

By
NORMAN H. CROWHURST

Part II—Rolloffs; network components; different voice coil impedances; phase

PART I of this article dealt with questions concerning the location of a crossover network, rolloff filters, filter and speaker terminations. Part II covers several additional questions asked about crossovers.

7. *Some recommend that in designing crossover units the rolloffs of the low- and high-pass sections of the crossover should be arranged to leave a gap in the overall response rather than overlapping to produce an overall response. What is the reason for this and is it a valid basis for design?*

The reason comes from the simple fact that a resonance is directly audible whereas an antiresonance is not. This can be better understood by considering a loudspeaker response without reference to crossovers for the moment.

If there is a peak in a loudspeaker response, as at Fig. 8-a, this peak will be noticeable whenever notes of this frequency are played because such tones get overemphasized and tend to show a hangover. However, a dip in response, as at Fig. 8-b, will be very much less noticeable because the positive demonstration of its presence will be lacking. If frequencies in this region drop to inaudibility due to the hole, we would not be conscious of their loss unless we are expert musicians. And if the result is merely a slight reduction in level, it will be less noticeable than an increase in level above the surrounding frequencies.

Applied to crossover networks, poor design methods result in a crossover that does not give an overall flat response. The response may rise to a peak in the vicinity of crossover or may produce an irregular combined response from the two units due to phase interference (discussed in answer to a later question). In either event the effect can be minimized by allowing the frequencies in this region to be attenuated rather than maintaining a flat response throughout the band.

It would be a waste of good material to use three loudspeakers to cover the audio band in three separate ranges, making the overall response flatter than is possible with a single unit, and then modify the response so as to have two holes in the response which the single unit would not have.

8. *Because of the possible resonance between inductance and capacitance elements in a filter, some recommend filters made up of resistance and capacitance elements only, on the argument that these cannot possibly ring. Is it possible to produce a satisfactory crossover filter using resistance and capacitance elements only?*

This arrangement would not be practical for use in a loudspeaker circuit because of the losses in the resistances. An inductance–capacitance filter does not introduce appreciable losses. So this question essentially relates to a crossover filter for use after the preamplifier and preceding the power amplifiers.

The first thing to notice about building a resistance–capacitance filter is that each resistance–capacitance combination produces a rolloff of 6 db per octave with a half-slope of 3 db per octave at 3 db down. If the values have been correctly chosen so that all the R-C combinations become additive at rolloff frequency—that is, the design has taken into account the interaction factor between the successive R-C elements—then, for example, a crossover arrangement using three resistors and three capacitors in each arm of the filter will produce a response which has a loss of 9 db at the crossover point and reaches an ultimate slope of 18 db (Fig. 9).

When the energy supplied through this crossover is combined acoustically at the output, the level at crossover frequency will be 6 db below the average level away from crossover frequency. Thus, this arrangement will result in a 6-db dip at crossover frequency.

To maintain uniform response throughout the frequency band the slope of the output of each filter at crossover frequency must be half the ultimate slope produced in the rolloff, and the attenuation at crossover frequency must be 3 db at this half-slope point. In this way the total energy at crossover frequency will be equal to the energy distributed to the individual units at frequencies well away from crossover, and the combined response will be maintained flat right through crossover. This ideal combination of frequencies is illustrated for differing sharpnesses of crossover response in Fig. 10.

For use between a preamplifier and the power amplifiers it is possible to design crossovers employing only resistance and capacitance elements *and using feedback* so as to produce a response identical with that of the more conventional constant-resistance crossover, using inductance and capacitance elements.

9. *Assuming we will use a conventional crossover design, having inductors and capacitors, which are the best kind of inductors to use: toroidal, air-cored or other iron-cored types?*

Each of these varieties of inductors has its own advantages and disadvantages. The best answer to this question will be to state them briefly for each kind.

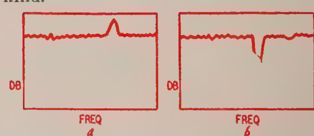


Fig. 8—Upward peak in response, *a*, is more noticeable than downward peak, *b*.

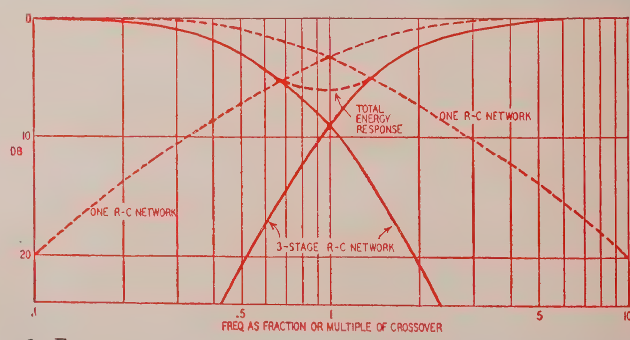


Fig. 9—Frequency response of two three-stage resistance–capacitance filters.

An air-cored inductor has the advantage that it cannot introduce distortion due to nonlinear magnetizing current because there is no core. This is about its only advantage. Due to the relatively low frequencies used in audio, particularly for crossovers, the Q of an air-cored coil is very low, unless the coil is made extremely large. Then its susceptibility to stray fields, such as hum, is very much greater than that of other kinds of inductors. So, this type of inductance needs careful shielding to avoid pickup of this kind, resulting in an inductor in a large copper "tank."

An iron core in an inductor improves its permeability and gives a much higher Q. If the iron core is correctly arranged it can also help discriminate against pickup of hum and other stray fields. This is the particular advantage of the toroidal construction, which is less susceptible to hum pickup, however it is placed, than any other kind of iron core.

However, especially for the lower-frequency crossovers, some other kind of iron core may provide a *cheaper* crossover. And if it is carefully designed, it need not be more susceptible to hum pickup nor introduce any more distortion that the toroidal type.

Due to the homogeneous nature of the construction of a toroidal core it has inherently lower distortion properties than other core materials that require an air gap. This does not necessarily mean, however, that it is not possible to achieve as low a distortion figure using other core materials with an air gap. What it does mean is that attention is necessary to avoid distortion, in designing a coil on other core materials, whereas when using a toroid the question of distortion can almost be forgotten.

10. *How can feedback be used in crossover design and how will the performance of a feedback crossover compare with one using inductances and capacitances?*

It is not possible to design a feedback crossover for supplying power to loudspeakers, so the comparison will be between an inductance and capacitance crossover designed for insertion between the preamplifier and power amplifiers and a feedback crossover to serve the same purpose.

Without going into a complete discussion of feedback crossover design, which would become a full-length article in itself, the general principle adopted is to use feedback to accentuate the rolloff of the resistance–capacitance type of filter described in question 9. Application of feedback over each of these filter elements will have two effects: it will sharpen the rolloff; it will shift its effective frequency.

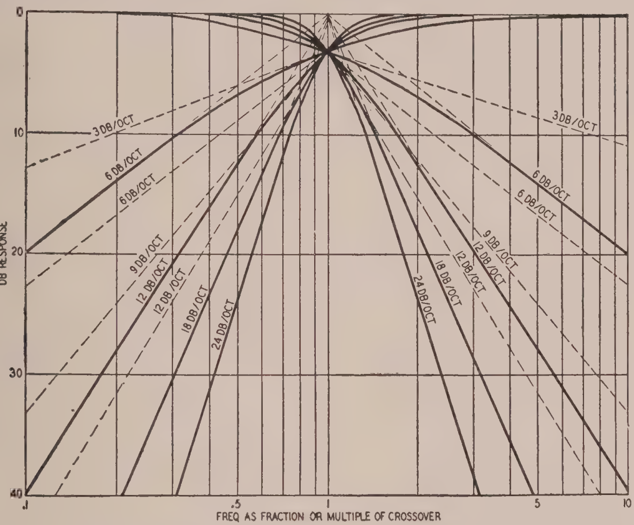


Fig. 10—Constant-resistance response curves. Dashed lines show slope features.

Filters using feedback in this manner require—for a 12-db-per-octave rolloff—in addition to the two resistances and two capacitances necessary to get the ultimate rolloff for each filter, a single stage of amplification to provide an effective negative feedback of 6 db which will produce the necessary sharpening and frequency shifting.

To get an 18-db-per-octave rolloff, R-C combinations of different time constants are used with a somewhat greater amount of overall feedback. To obtain a 24-db-per-octave rolloff, two separate networks are used in cascade, each with its own feedback network, requiring differing R-C rolloff frequencies and amounts of feedback. Thus, when the responses are combined, the overall response is of the correct shape.

The only possible advantage to be claimed for the feedback networks is that they avoid the use of inductances. Because they produce the same overall response as the prototype filters using inductances and capacitances, they are just as susceptible to transient distortion and spurious phase effects.

They are, if anything, a little more difficult to adjust because of the greater number of components that go to make them up. For example, a 12-db-per-octave filter requires two resistances, two capacitances and careful feedback adjustment for each section. An L-C arrangement equivalent to it has only one inductance and one capacitance to adjust to correct value. For the 24-db-per-octave variety the circuit is extremely more complicated than its inductance–capacitance counterpart.

So the only advantage possible is inherent avoidance of the slight amount of distortion and stray-field pickup that may possibly be encountered with the use of inductors. It would surely be a better approach to use high-quality inductors and save a lot of trouble, with the additional advantage that a good inductor will stay put whereas a complicated feedback circuit is likely to drift due to a variation in some of the many values on which it depends or the gain of the tube.

11. *Can a crossover network be used to feed loudspeakers having different voice-coil impedances?*

In answering this question—as well as some of the others—one is tempted to say: "It is possible to do what you like if it sounds right." But such an answer would not be consistent with the purpose of this article!

We are concerned with how to use equipment to achieve minimum distortion in reproduction. Sure, we *can* connect a 2-ohm loudspeaker to the terminals of an amplifier designed to be loaded with 16 ohms . . . and it *may* sound fairly passable. But the available output of the amplifier will be seriously limited and it will probably give a higher than rated distortion.

So the answer to the question is that no simple crossover circuit, employing only inductors and capacitors, can match two different loudspeaker impedances so as to present a constant resistive impedance at the input to the network for connecting to the amplifier output.

There are three ways of solving this problem: First, the impedances of the loudspeakers can be "padded" by resistances so that the termination on both crossover outputs is the same. For example, a 2-ohm unit could be padded to 6 ohms by inserting a 4-ohm series

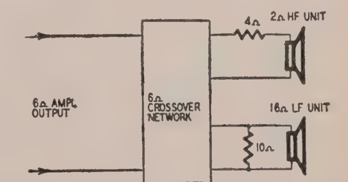


Fig. 11—Adapting a crossover to use different voice-coil resistances. This provides correct matching but wastes power.

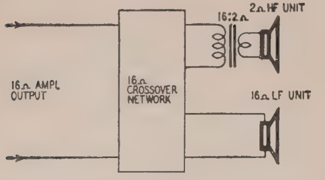


Fig. 12—Using a matching transformer for different voice-coil resistances.

resistor; similarly 10 ohms across a 16-ohm loudspeaker will bring its impedance down to about 6 ohms. The crossover unit could then be designed for 6 ohms and the amplifier should be matched into a load of 6 ohms. This arrangement is shown in Fig. 11.

The disadvantage of this method is that two-thirds of the power output will be delivered to the resistances and only one-third to the loudspeakers, a costly waste of audio power.

The second method would be to use a matching transformer (Fig. 12) in one of the loudspeakers. Probably the best arrangement would be to use an autotransformer to match the impedance of the 2-ohm unit to 16 ohms and then use a 16-ohm crossover and the 16-ohm tap on the amplifier output.

The third method utilizes an invention of mine. Two prototypes have so far been built and it is hoped that arrangements will soon be made with a manufacturer to put them in production. The unit may be called a "universal crossover transformer." It uses certain leakage inductances in the transformer for the inductors of the crossover network. This avoids any distortion in the elements of the crossover because leakage inductance is basically an air-cored inductance, although it appears in an iron-cored component.

The complete unit provides for matching to any plate-to-plate impedance, with provision of taps suitable for Ultra-Linear operation, or feedback from the primary side, and also provides an arrangement for selecting different crossover frequencies. Taps are available on the separate output circuits of the unit so that any variety of loudspeaker impedances can be matched to provide a constant-resistance plate-to-plate load for the output tubes. This whole unit should cost very little more in production than a good-quality output transformer for a single impedance. It is equivalent to a multi-ratio output transformer; a multiple-frequency crossover unit; a speaker-matching transformer for each band—all in a single unit costing little more than one of them.

12. *What about phase in crossover networks? How does this affect the performance of the system?*

Using constant-resistance design correctly matched to two speakers, the overall response is flat and the phase difference between the energy supplied to the two units is constant at all frequencies: 90° for the single-element 6-db-per-octave; 180° for the two-element 12-db-per-octave; 270° for the three-element 18-db-per-octave; 360° for the four-element 24-db-per-octave type. But there is a progressive phase shift with frequency for these networks as shown in Fig. 2 (Part I) in the section on ringing.

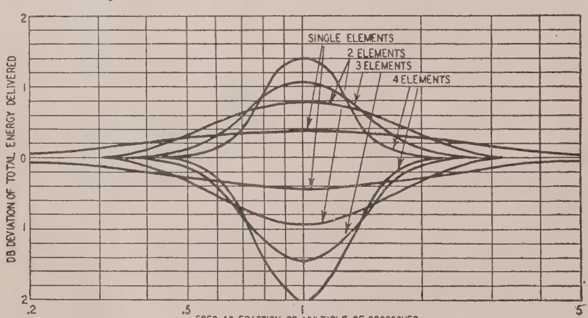


Fig. 13—Deviation from correct response due to 10% error in component values, for elements in constant–resistance type.

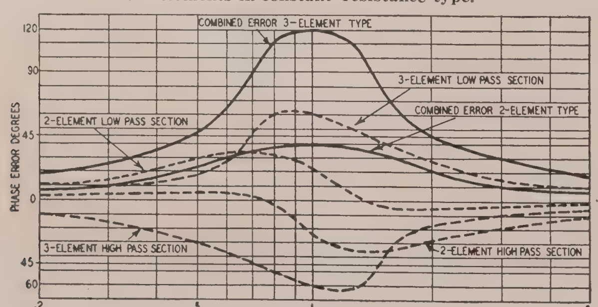


Fig. 14—Phase error introduced by "standard" crossover filters—not constant-resistance. Dashed lines show the part contributed by each section; solid lines show total error due to both.

There is another argument here for the use of simpler crossovers. Fig. 13 shows the affect of 10% deviation in element values on the ultimate response of the combined network. This can cause an appreciable peak or hole in the overall response, using four-element 24-db-per-octave dividing networks whereas it is reasonable using a two-element 12-db-per-octave type.

This data relates to the constant-resistance type. With the older type of filter there is considerable inherent deviation of phase in the vicinity of crossover. Fig. 14 shows the deviation from the average phase displacement of 180° and 270° for filters employing two and three elements in each half, respectively. This question thus points up another very good reason for using correctly terminated filters of the constant-resistance variety.

13. *How about using multiple speakers employing crossovers on amplifiers provided with variable damping? Is there any interaction between them?*

There are two factors to consider and both of them point to the advisability of using the constant-resistance kind of crossover. Using a crossover whose impedance deviates appreciably from nominal in the crossover vicinity, as is the case with all except the constant-resistance types, the overall response delivered to the crossover unit is considerably affected by the source impedance from which it operates (see answer to question 6, Part I).

But there is a further aggravating factor that can appear with some kinds of variable damping systems. A crossover that introduces fluctuations in impedance also introduces reactance components near the crossover frequency. If the variable amounts of positive and negative feedback employed by the variable damping amplifier are at all susceptible to reactance components at these frequencies, the variations in frequency response may even be further exaggerated by the amplifier due to the peculiar effect the feedback adds to the response.

However, using a crossover of the constant-resistance variety will add no more peculiarities than the same amplifier would produce when operating into a single loudspeaker.

Sometimes, to obtain the desired overall response, the loudspeaker manufacturer "cheats" a little by using slightly different voice-coil resistances. This is legitimate, although it would be frowned upon academically. But the application of variable damping will show it up, by changing the level distribution to the different units as damping factor is changed. END

FOR GOLDEN EARS ONLY

Dynakit amplifier; Heathkit harmonic-distortion meter; Goodman Axiom 80 speaker systems

By MONITOR

THE great problem in designing a wide-range amplifier is obtaining and maintaining adequate stability at sub- and ultrasonic frequencies. Many a commercial, as well as home-built amplifier, meets ideal specifications in response, distortion, etc., within the audible range but suffers from transients caused by momentary instability at the extreme limits of the response. These degrade definition, vastly increase distortion on transient peaks, lead to hangover on low bass transients, overload (and sometimes burn out) speakers and, through high-frequency ringing, produce a mysteriously painful fatigue. Most of the trouble results from carrying the feedback beyond the critical point in an attempt to achieve either extreme frequency range or very low distortion.

David Hafler, who with his former partner, Herb Keroes, was responsible for the Ultra-Linear configuration and the fine series of output transformers which made the circuit work so well, has come up with another inspired design—Dynakit amplifier (Fig. 1) which he is marketing through his own firm, Dyna Co. It is a beautifully simple answer to the problem. The secret is almost entirely in a two-stage front end, with a pentode amplifier followed by a split-load inverter. The combination has many virtues not apparent at first glance. There is a single low-frequency time constant within the feedback loop, and the high-frequency time constants are also reduced by the elimination of other stages. The pentode has a better high-frequency response because it is free of Miller effect. Consequently the phase shift within the loop is much less at both ends than in, for example, the Williamson circuit which has an additional stage and uses triode input.

The EL34's in the output are actually used as pentodes with a slight amount of screen feedback to lower plate resistance. Pentode operation requires much less drive and the front end is not driven as far into the curve on peaks as it would be with either triode or Ultra-Linear operation. Furthermore, there is less high-frequency phase shift. These particular tubes, according to Hafler's experiments, work better as pentodes.

Measures are taken to stabilize the feedback loop. It has the usual high-frequency compensation in the form of the capacitance across the feedback resistor. Additional phase compensation, however, is added by an inner feedback loop from the screen of one of the output tubes to the input-tube cathode. The capacitor provides feedback only at ultrasonic frequencies, thus holding down the gain of the feedback loop in that range.

A similar step is obtained in the subsonic range by the bypass capacitor for the screen of the input pentode. The result is an amplifier whose frequency response, distortion, etc., will match just about anything on the market, but with extraordinary stability at both ends.

The frequency response curve (Fig. 2-a), I suspect, does not do the amplifier complete justice. My vtvm begins to slope at the extremes, and it is possible that most of the indicated slope above 50,000 (and below 10) cycles is due to the vtvm rather than to the amplifier. Even so, response is within 1 db from

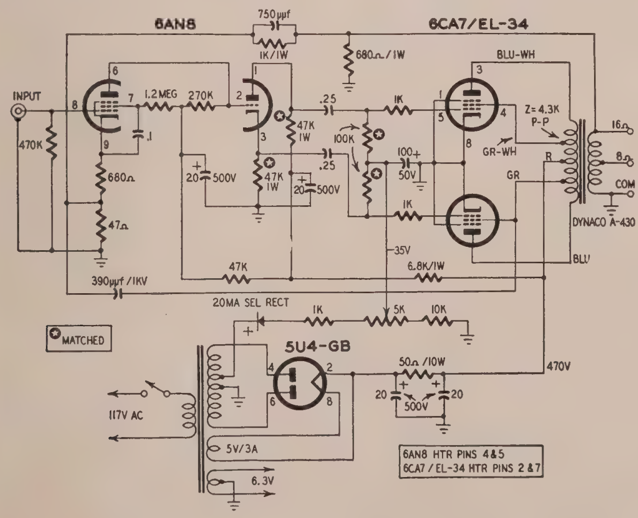
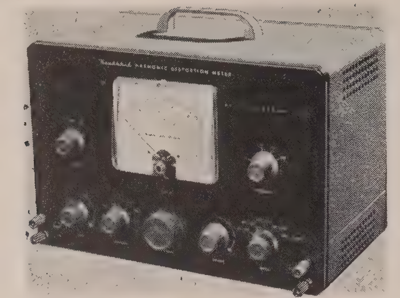


Fig. 1—Schematic diagram of the Dynakit 50-watt power amplifier kit.

The Dynakit with protective cover.



Heathkit harmonic-distortion meter.

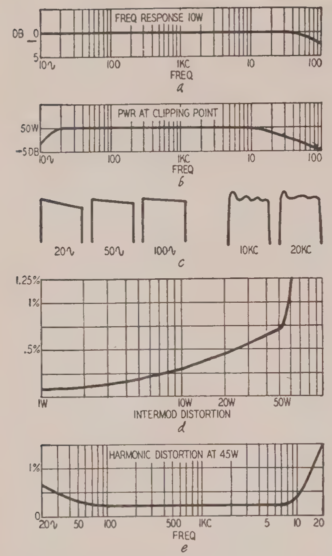


Fig. 2—Curves show characteristics of Dynakit amplifier: a—frequency response; b—power output; c—square-wave response; d—intermodulation distortion; e—harmonic distortion.

5 to 50,000 cycles. The power output curve (Fig. 2-b) is superb. The amplifier delivers full output from 20 to 10,000 cycles and is only 1 db down at 20,000 and 5 db at 50,000 cycles. It is rated at 50 watts, though the model tested delivered 58 watts at 1,000 cycles. The square-wave response (Fig. 2-c) is also very good. The intermodulation distortion at 50 watts was 0.7% (Fig. 2-d). The harmonic-distortion curve (Fig. 2-e) is also unusual: 0.2% is not exceeded between 60 and 7,000 cycles at 45 watts and rises only moderately at the extreme ends.

The Dynakit amplifier has to be heard to be fully appreciated. Its stability is shown by a remarkable definition and cleanness of both bass and high-high ends. Bass instruments are especially natural and free of muddiness. The high reserve power provides so great a margin that even the greatest bass transient peak comes through without audible strain.

The entire front end comes preassembled and prewired on a printed-circuit board. The remaining wiring is noncritical. The veriest novice should have no trouble putting the kit together and obtaining proper performance.

Heathkit harmonic-distortion meter

Intermodulation distortion provides an excellent measure of overall amplifier performance and one which corresponds closely with listening quality. But no single approach ever tells the whole story and IM measurements can overlook important facets of performance. Moreover, broadcast equipment and tape recorders, among others, are still rated in terms of harmonic distortion and anyone dealing with this type of equipment needs to measure harmonic distortion rather than IM.

There has long been a need for a simple and inexpensive instrument for measuring harmonic distortion. The Heathkit HD-1 not only fills the need nicely but at a price well within the capacity of thin budgets. It will, no doubt, be of greatest usefulness to the design engineer but it should also be highly useful to the service technician dealing with broadcast and high-fidelity equipment and many serious amateur experimenters.

The HD-1 is a null type instrument (Fig. 3). The fundamental is suppressed by a filter network and the remaining components are measured by a built-in voltmeter. As in all such meters, the measured residue includes noise and hum both within the equipment under test and the audio generator and meter itself. Therefore, the accuracy of readings at very low levels of distortion (under ½%) is questionable unless one measures the noise and distortion of the generator, the total noise of the equipment tested and subtracts this from the final figure. However, readings above ½% will in most cases be sufficiently accurate for almost any purpose without subtracting the residual noise. The residual reading of the HD-1 itself can be disregarded. The specifications call for a residual reading of 0.1% or less; in my sample it is actually under .05%.

The reading itself gives no idea of the exact nature of the distortion. However, there is a set of output posts so that the filtered signal can be fed into a scope. Examination of the scope pattern with a roughly calibrated sweep will give a good indication of the type

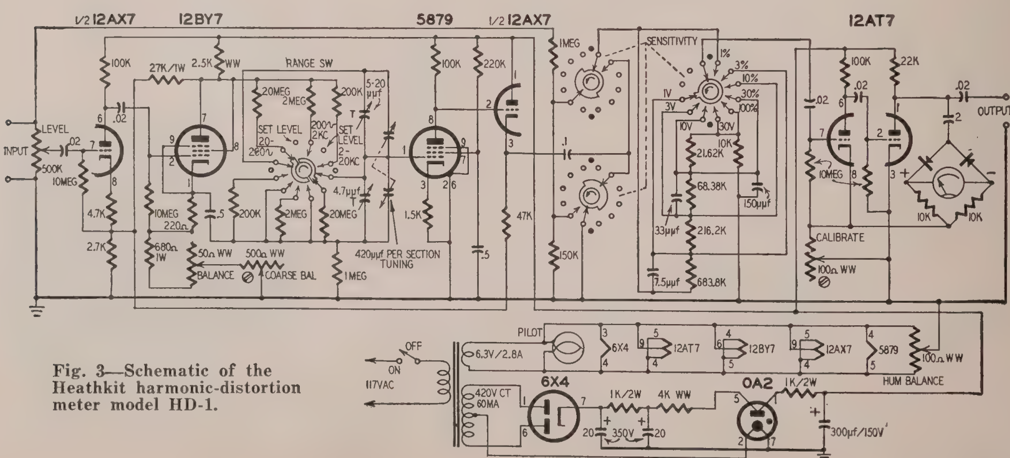


Fig. 3—Schematic of the Heathkit harmonic-distortion meter model HD-1.

of distortion involved and even of the proportion of hum and noise.

The instrument is designed to provide ease and convenience of operation. Individual readings can be made quickly and a complete sweep of the 20–20,000-cycle range by octaves need not take more than 10 or 15 minutes. The null is very sharp and the attenuation of the region an octave or more above or below the test frequency is insignificant.

Although the specifications state that an input of 0.3 volt is needed to take a distortion reading, it is possible through some interpolation to make measurements with lower input voltages, although the accuracy of the readings—especially at low levels—will fall off considerably.

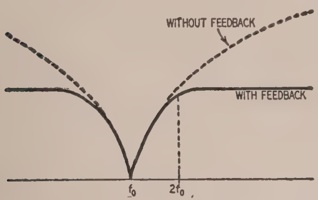


Fig. 4—Effect of the feedback loop.

Ordinary procedure calls for adjusting the level with the sensitivity switch in the 100% position. But it is possible to set level on the 30, 10 or even lower positions of the sensitivity switch. Thus an input voltage of only 100 mv will provide a full-scale reading when the switch is on the 30% stop and an input voltage of 30 mv will produce a full-scale reading on the 10% position.

After nulling out the fundamental, the distortion scales are interpolated thus: the 100% scale applied to the range position at which the full-scale level was set, the 30% scale to the next lower switch position, etc. Thus if a 100-mv signal is adjusted to provide full-scale set-level on the 30% position, the 100% scale will apply to this position, the 30% scale will apply when the switch is turned to the 10% position, the 10% scale when the switch is turned to 3%. Although at low distortion levels the error due to the residual noise of the instrument itself is increased, the readings are accurate enough for comparative purposes in design, development and adjustment—as for example, in adjusting the tracking error of pickups, the bias in low-level amplifiers, etc.

The voltmeter, which can be used independently as an ac vtvm is linear within 1 db over the full 20–20,000-cycle frequency range and also within 1 db on each scale and on adjacent scales. The lowest voltage scale on the instrument is 1 volt, but by using the amplifier chain in the harmonic-distortion filter as a preamplifier (the procedure is described in the handbook which comes with the instrument) it is easily possible to obtain full-scale readings of voltages as low as 3 mv. This provides sufficient sensitivity to read the output of almost any pickup or microphone.

The HD-1 can be used also as a continuously tunable band-rejection filter covering the entire audio spectrum. It could even be used at the output of a communication receiver to filter out beat notes, interference, monkey chatter, etc.

The high sensitivity range of the voltmeter provides a most convenient instrument for making frequency runs of pickups, equalizers, tone controls, etc., because the level control can be adjusted to provide a reading of zero db with just about any input voltage and there is no need to interpolate meter readings when making a run—the deviations, plus or minus, can be transferred directly to graph paper or to a table.

The circuit of the instrument's filter portion should be of considerable interest to designers and experimenters. The filter operates through a Wien-bridge network inserted in both legs of a split-load inverter. The response of a Wien-bridge network, not sharp and steep enough of itself, is improved by running a feedback loop around the filter with the effect noted in Fig. 4. Hams might find the front part of the circuit useful for eliminating beat-note interference and hi-fi enthusiasts who do not mind complication might also find it useful for attenuating hum, rumble, interchannel beat notes, etc.

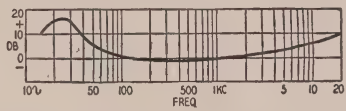


Fig. 5—Impedance curve of Axiom speaker system with four type 80 units.

Goodman Axiom 80 speaker systems

The Axiom 80, introduced some years ago, is a remarkable speaker. It has a cone about 8 inches in diameter with a very flexible three-point suspension which gives it a resonance in free air of about 17 or 18 cycles and a claimed response from 20 to 20,000 cycles. It has worked fine in infinite baffles of the wall type, but it has been a difficult speaker to mate with smaller cabinets because the charts and formulas for enclosures require considerable modification to work with its unconventional characteristics.

The typical bass-reflex enclosure, for example, is usually designed to resonate at a lower frequency than speaker resonance, but it would take a tremendous enclosure to resonate at a frequency below 18 cycles. Attempts to mount it in conventional enclosures have almost invariably resulted in uninspiring performance.

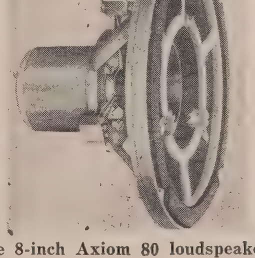
Recently the American importers of these fine British speakers have had a series of enclosures designed especially for it. They sent me three systems—one with a single 80, another with a pair of 80's and a third with four 80's. If my reaction is at all representative, these systems should find wide favor.

The smallest, with the single 80, is one of the best compact speaker systems on the market but it is easily overloaded and should be used only when the input is not much over 5 watts. It has an exceptionally clean and well defined bass and goes far enough down to provide considerable awesomeness. Until the overload point it is free of doubling and distortion. The high end is exceptionally good.

The biggest outfit with four speakers goes right into the category of finest possible systems. The larger enclosure and the improvement in efficiency and distortion level due to mutual coupling of the four cones produce one of the most pleasant and natural bass responses I have ever heard. Fig. 5 gives the impedance curve. A single peak, unusually gentle in slope and centering around 25 cycles, damps out nicely with typical modern amplifiers. The response goes below 30 cycles and there is little doubling until the input level becomes very high. Efficiency is very high. In fact, it is neither necessary nor desirable to boost the bass much even at very low levels—even these four speakers can be overloaded quickly. The overload is usually the result of rumble, hum and subsonic transients.

When overloaded, the cones flap against the suspension with much audible rattling. On this account, I would not recommend use of these systems with amplifiers prone to breathing or momentary oscillation at subsonic frequencies. But with highly stable amplifiers they will deliver all the bass any home can stand with a most admirable purity, naturalness and freedom from coloration. The high end is most pleasant to my ear, too. The four speakers produce an extremely wide sound source throughout the whole frequency range and the balance between highs, lows and middle is far better than with systems using separate speakers for various portions of the spectrum.

The less expensive and smaller system with two speakers provides performance which is not very much different—though it is more likely to overload. The enclosures appear to solve the problem presented by these speakers very nicely and should result in a much wider appreciation of the fine qualities they possess. END



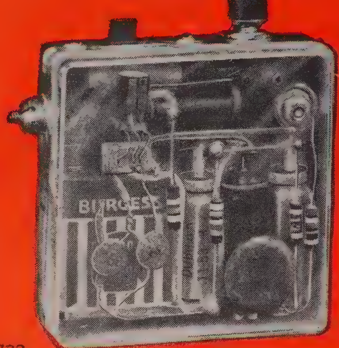
The 8-inch Axiom 80 loudspeaker.

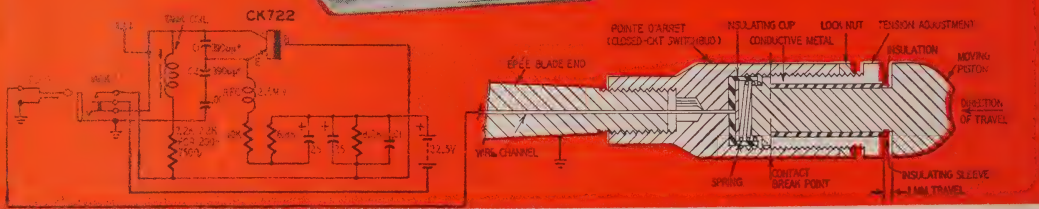
COVER FEATURE

Electronic Brain Scores Fencing Hits

Transistors and electronic circuitry provide foolproof automatic scoring in foil, saber and épée matches.

By IRA C. DAVEY





The transistorized transmitter and *pointe d'arrét* used in épée matches.

IN the swashbuckling days of the sword and pike, a man's very life depended on his ability to defend himself or destroy his opponent. The murderous mayhem of a few hundred years ago has developed into the modern body-building sport of fencing. The mayhem has been removed, but the lightning speed of the blade and the development of skill in body movement have become a physical-culture science. Skilled fencing today is definitely faster than the eyes can follow and there are always occasions where the awarding of a score point was given in truthful ignorance of any error. Because of this speed–error factor, the electrical épée was developed and accepted internationally as a medium to indicate the faster-than-the-eye touch.

There are more than 1,700 fencing groups in schools and colleges and private clubs within the United States, and European clubs and fencers outnumber those in the Western World. Modern fencing weapons are the foil, épée and saber. All three are used and international rules apply to bouts and contests with each. Men usually fence with all three; women use the light and flexible foil. The tips of the weapons are now blunt or padded to prevent injury as only a direct thrust to the target counts as a touch. Side swipes or sweeping blows do not count.

In épée contests, all parts of the body are vulnerable and are targets for attack and touch. Any portion of the body from heel to top of head touched by the opposing combatant is counted as a point in scoring.

In foil fencing for both men and women, the target area is limited to the space between a line running around the hip bones and a top line at the collar and excludes the arms or sleeves.

Electrical épée scorer

The official electrical épée equipment designed to register the touch and scoring is a wired system of low resistance using buzzers and a pair of indicating lights that are energized and held in an active binary state until manually released. The equipment is energized by an open- or closed-circuit switch mounted on the tip of the épée blade. This switch, or pointe d'arrêt as it is called, is spring-operated. The spring resists a make or break contact until an approximate pressure of 750 grams (about 26.5 ounces) operates it. The blade is of a triangularly formed length that is broadest at the handle and guard end and gradually tapers to a small overall diameter at the tip end where the switch or pointe d'arrêt is attached by machined threading.

An insulated Litz wire lead from the switch is cemented in a groove that extends the length of the blade to a plug inside the guard. The mating of the plug extends the conductors to a body wire that runs through and up the sleeve and out the back of the fencing jacket to a harness loop that holds the reel wire. The wire is attached to a floor-mounted, recoilable, spring-activated winding reel that allows forward movement and rewinds the slackened wire as the fencer retreats to the base of the reel. Variations of pull on the reel from 10 pounds at 10 feet to 18 pounds at 15 feet have been observed. In a spirited bout any sudden retreat or backward movement will unfortunately tangle the wire about the feet of the contestant. Another disadvantage of the electrical touch indicator is that in the case of almost simultaneous hits, the judge or scorekeeper may not see which light goes on first. Furthermore, the electrical scorer is limited in its use to épée contests since these permit touches on any part of the body. It cannot be used to score saber or foil contests because illegal touches—those outside the prescribed area—would close the pressure-operated switches.

Electronic scorer

My new electronic scorer (patent pending) was developed to overcome the disadvantages of the electric type. Each contestant wears a miniature radio transmitter that eliminates the encumbrance of the wires and the danger of tripping. The circuits in the scorer are interlocked so that when a fencer scores, his opponent's scoring circuit is interrupted for a few seconds. The contest continues after the circuits are automatically restored. This eliminates errors on the part of the judge and only scores the first of two quick thrusts. The new system also permits scoring of fencing matches using the foil or saber.

The miniature transmitters worn by combatants are transistorized and are small enough (2½ x 2½ x 1 inch) to fit snugly into a pocket on the outside back of the fencing jacket. Each trans-

mitter (see diagram) is tuned to a different frequency and transmits its signal to a receiver in the scoreboard.

The photo on the cover shows the electronic scorer as used in a match with foils at the YWCA in New Haven, Conn. A low-resistance conductive cloth (manufactured by M. Swift & Sons, of Hartford, Conn.) is made a part of the fencing jacket. A special tip or pointe d'arrêt was designed for the foil. An open-circuit switch that closes only when pressure is applied and contact is made with the conductive cloth completes the circuit. Thus, all touches applied with proper pressure to the area covered by the conductive cloth will complete the circuit. To prevent the registering of touches on the guard and metal mesh of the mask an insulating lacquer covers the conductive surfaces.

The transmitter diagram shows a general method of applying the closed-circuit switch of the épée. The blade and the fencer's body are used as an antenna. The battery circuit is closed automatically by inserting the body-wire plug into the transmitter jack. The unit oscillates with the closing of the battery switch but radiation is prevented by the normally closed épée switch. The insulated lead in the grooved blade is the antenna and also the conductor to the closed-circuit pointe d'arrêt. The return path to ground is through the blade. Thus, the tank circuit is shorted and radiation prohibited. Opening the switch allows instantaneous radiation within microsecond limits.

Frequency is controlled by the tank capacitors C1 and C2 and the ferrite slug of the tank coil. Experiments with identical components in two transmitters' tank circuits and at peak signal output allowed a tuning range from 500–800 kc with a minimum of 60-kc separation.

Transmitter output is low and within the low-power provisions of the FCC regulations. Signal-to-noise ratio may be increased by running the receiver antennas under the tape marking the sides of the fencing court. The transmitters are tuned to dead spots in the broadcast band to avoid interference from local stations.

The receivers are standard broadcast sets modified to operate sensitive quick-acting plate-circuit relays instead of speakers. In electrical épée bouts it is a common occurrence to see clean thrusts of proper pressure that are too fast to operate the indicating circuits. For this reason the plate relays feed the visual and audible touch and scoring indicators through a system of delay and hold networks.

When a touch is made, an alarm sounds for 4 seconds or so and the scoreboard indicates the combatant making the score. The circuits are locked out for a few seconds and then restored to permit the match to resume. The scoreboard automatically resets to zero when either side has scored 3 out of a possible 5. END

solar flare indicator

Receiver detects solar storms; warns of impending radio blackouts

By DAVID WARSHAW *

SUNSPOT maximum, expected in the middle of 1957, is going to cause a lot of unexpected—and freakish—conditions which will affect commercial and amateur shortwave radio communications and the lower television channels. Everyone interested in these forms of communication is likely to be confronted with strange phenomena, for which, in many cases, equipment may be blamed. Television salesmen and service technicians, especially, may be faced with irate customers complaining about ghosts from distant stations; shortwave radio technicians and amateurs will experience sudden radio fadeouts. All these unusual conditions will be created by the sunspot maximum which is predicted to be the greatest in history. An instrument which should be of great value during this time is this transistorized solar-flare indicator.

The solar-flare indicator—actually an atmospheric radio receiver—is tiny. It sets off an alarm at the time of a solar flare, indicates the exact instant when shortwave communications will fade out and even forecasts magnetic and ionospheric storms and auroras 26 hours in advance.

Flare detection is now a matter of increasing importance to solar and ionospheric workers. The *SEA* or *Sudden Enhancement of Atmospherics* method is sufficiently sensitive to detect practically all class-2 and class-3 flares which occur between sunrise and sun-

* Technical supervisor, American Cable and Radio Corp.

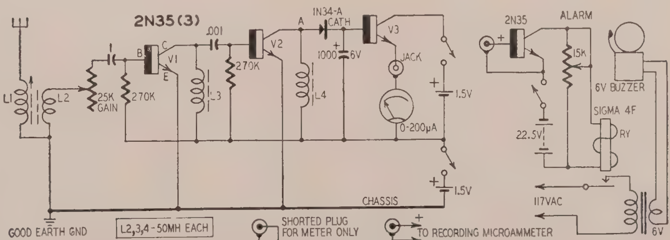
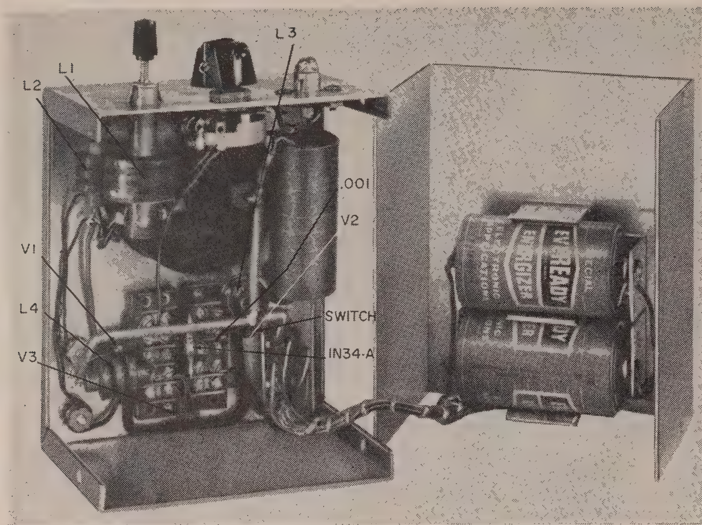


Fig. 1—Schematic diagram of the solar-flare indicator and alarm system.



Layout of indicator parts—all chokes are supported by the heavy wire.

set. It follows, then, that if a number of solar-flare indicators could be well distributed in longitude, no major flare should pass undetected for lack of direct observation. The SEA method makes it possible to fix, within narrow limits, the times of beginning and maximum of a flare. It would, therefore, be of great value to solar research if a number of these receivers could be in operation, in both America and Japan, in time for the International Geophysical Year of 1957–58.

Indicator construction

A solar-flare indicator (Fig. 1) can be built easily at a very small cost. The parts are mounted as shown in the photograph. Each coil is mounted with its axis in a different plane to minimize the chances of oscillation. Use No. 14 solid-copper plastic-covered wire to keep the coils rigid. Do not solder the transistor leads—heat will affect their quality. Cut each transistor lead to about ½ inch, which then can be fastened neatly under the screws of the terminal strips. The coupling of L1 and L2 is close and the L2 mounting must be rigid. The optimum spacing between L1 and L2 depends on antenna length and the normal setting of the gain control and must be determined experimentally. Mount the output jack

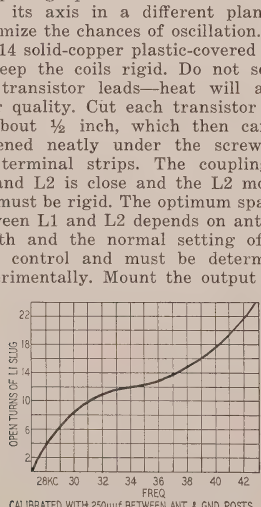


Fig. 2—Receiver calibration chart.

with an insulating or fiber washer to insulate it from the chassis.

Provision was made for oscilloscope inspection by mounting a pin jack just above the on–off switch, connected to point A. This is not really necessary because the parts, used and mounted as shown, should operate within the frequency range of 28 to 43 kc, using an inverted-L antenna 50 feet long (preferably along an east–west line) and 50 feet high. The calibration chart (Fig. 2) proved accurate even when parts were interchanged. Unwinding the L1 slug eight turns provides 30-kc reception with a bandwidth of only 200 cycles. The 30-kc setting in New York City is ideal since the nearest possible interfering frequency is 26 kc, used by the Air Force at Marion, Mass., and its bandwidth is extended but the receiver rejects this completely.

The very narrow bandwidth of the receiver is due to the high-Q ferrite-core coils. Only the parts shown should be used. The 1,000-μf 6-volt dry electrolytic provides a charge–discharge time constant to keep the current in the dc amplifier steady between atmospheric pulses and to indicate average readings on the meter. This is also affected by the gain control, which could cause oscillation when set too high. If oscillation occurs and the meter goes off scale, turn the gain control down and flip the switch off, then on again, allowing the capacitor to discharge itself during the off period.

For visual inspection of the atmospheric pulses, an oscilloscope may be connected to point A and chassis. The scope may also be used for visual alignment with a signal generator when the receiver has a very long antenna or long indoor lead-in which will increase the capacitance across L1 and thus lower the frequencies. The antenna should be about 50 feet above ground and *as long as possible*. At these low frequencies a very small part of a wavelength is several hundred feet long. A 50-foot-long inverted-L single-wire antenna about 50 feet high (or 200 feet long with a 500-μμf series capacitor) was used to produce the calibration chart. A 250-μμf capacitor across the antenna and ground terminals, as a dummy antenna, will also give the same figures. Every 75 feet added to the antenna length will reduce the calibration chart frequencies by roughly 5 kc.

At 30 kc atmospheric pulses reach approximately 250 peak microvolts per meter in daytime and 700 at night between latitudes 30° and 50°; latitudes 50° to 90° one-tenth these values; 10° to 30° twice; 0° to 10° five times. These are standard values for receivers of 10-kc bandwidth and vary as the square root of receiver bandwidth. The batteries should last for years since the current drain is less than ½ milliampere. Observe the polarity carefully —the wrong polarity may ruin the transistors.

Methods of indication

The receiver (sensitivity 33 μv per meter for 25 μamps output) may be used to indicate solar flares by the 0–200-μamp meter built into the unit or by an alarm buzzer which may be plugged into the phono type jack at the top. The alarm system consists of an additional transistor and buzzer in a small metal container which plugs into the solar-flare indicator and can be adjusted to sound off at any desired meter reading. Records of readings and their associated shortwave fade-outs are as follows: Feb. 16, 1956, at 1808 to 1913 Greenwich time, the microammeter showed a sudden rise from 40 to 80. On Feb. 18, 1956, at 1608 it registered 75. Feb. 19, 1956, from 1437 to 1600 it registered 85. March 13, 1956, at 1455 to 1545 it registered 100. March 15, 1956, at 1625 to 1700 it again registered 100. March 31, 1956, at 1335 to 1410 it registered 80. April 1, 1956, at 1416 to 1500 it showed 75.

The recording microammeter method is best for indication and a running record can be kept for future reference. This method is quite expensive. However, if used, it should be set to run at 1 inch per hour. Whether the alarm or recorder method is used, either may be easily plugged into the unit. The switch should be turned on and the gain control set to the highest meter reading possible at night, but not during a local thunderstorm. The receiver will then be ready for any sudden increase after sunrise of about 100% —which indicates a solar flare. The night readings are always two to three times higher than the daytime reading normally, because of better atmospheric propagation.

Solar-flare indicators have been used by observatories in Europe for several

years by both Dr. M. A. Ellison of the Royal Observatory, Edinburgh, Scotland, and Dr. Max Waldmeir, of Zurich, Switzerland. They contain several pentode tubes, two stages of amplification, voltage regulation and special biasing components for constant regulated output indications. The indicator described here has all the important features of the European atmospheric receivers with the added advantages of a minimum number of components and a large reduction in cost. Since transistors are highly stable current devices and dry cells are a source of regulated voltage, they go very well together to produce a very simple, highly efficient receiver.

The most important effect of solar flares is the improvement by about 100% of the propagation of radio waves from 10–50 kc originating in tropical storm centers in the form of atmospheric pulses. It is now generally accepted that the ultra-violet light generated in a solar flare produces extra ionization layers in the D-layer region from which these frequencies are reflected.

In 1937, it was found that propagation frequencies from 10 to 50 kc improved during a solar flare. During the time that 10-to-50-kc signals are improved, the frequencies used for overseas communications are useless because of the flare effects. In Europe, 27 kc is used, but in the United States we must use 30 kc because of the Air Force Station in Marion, Mass. The recordings of SEA's are with respect to increasing solar-flare classes 1, 2, 3 and 3 plus.

The atmospherics on low frequencies originate in the tropical thunderstorms from which we have a continuous source of surprisingly steady radio transmission which furnishes us with information of a better nature than any other source of radio transmission. The level of these atmospheric pulses gradually increases at night to let us know the receiver is functioning properly and is ready to indicate SEA's during the daylight hours, thereby simultaneously indicating solar flares which cause them.

The conductivity of the ionosphere, or the reflection coefficient of the radio reflecting layers, is due to its electron density which is formed by the action of the Sun's ultra-violet light. The electron density increases with the height of the layer, and the higher frequencies are thus better reflected from the higher layers. During a solar-flare eruption, the lowest (D) layer, which is about 50 miles above the earth, becomes greatly overionized and stops the radio signals trying to reach the higher E and F layers. This increase in electron density, however, makes a better reflecting layer for the very low frequencies, while at the same time absorbing most of the energy of the higher frequencies used for overseas communications.

The concentration of the increased density is somewhat proportional to the decrease in signal strength. That is, when the signal is only one-tenth its normal strength, the increased density is 10 times. The higher frequencies are thus suddenly absorbed, while the very low frequencies are enhanced just as suddenly as the flash of ultra-violet from the solar flare occurs.

The return of signal strength to normal is a much slower process and is probably due to some of the free electrons recombining with positive ions and neutral atoms forming negative ions and slowly returning the layers to normal density. Sometimes the return to normal density of the D region may take an hour, depending upon the size and intensity of the flare.

During the sunspot maximum years of 1957 and 1958, shortwave fadeouts (SWF) from solar flares may occur as often as a few times during a single day. The simultaneous effects are most severe at the subsolar point, which is the noon location, or where the sun is overhead. Although shortwave fadeouts are temporary blackouts of long-distance communication, intense flares also cause charged particles to shower the ionosphere a day later. This, in turn, results in magnetic storms, ionospheric storms and auroras. This latter, or prolonged, effect is most harmful to communications.

It is, therefore, very important and useful to the communications industry to know beforehand the possibility of such prolonged conditions. When this knowledge is obtained a day in advance, arrangements can be worked out for rerouting radio traffic. Prediction of prolonged fadeouts depends largely upon the location and intensity of a solar flare. Class-3 flares, which are within 45° of the solar central meridian, are certain to cause prolonged radio fadeouts 26 hours later.

In summarizing, the solar flare not only emits wave radiation with immediate effects but it also emits particle radiation with delayed effects because of slower travel speed. The charged particles or corpuscles blown off during a flare may be due either to electromagnetic forces or the terrific pressures of the flare's ultra-violet radiation. They influence the Earth's magnetism by setting up great currents of electricity, causing magnetic storms and brilliant auroral displays extending from the north and south polar regions sometimes (in exceptional cases) as far as the Equator.

Solar flares are usually associated with shortwave fadeouts in the frequency spectrum of 5 to 20 mc, and bursts of radio noise in the much higher spectrum of 50 to 250 mc. At 1420 mc or about 21 cm, the radio noise from interstellar space has recently presented new views of our universe, far beyond the visual range of our largest optical telescopes. The frequency of hydrogen in space, 1420 mc, emitted from the flares of the other myriads of "radio stars" besides our Sun, makes it possible for new maps of the universe to be plotted. This has opened up great new avenues of investigation into radio astronomy.

Solar flares are flashes of ultra-violet radiation exploding on the Sun with forces much greater than millions of hydrogen bombs. The amount of ultra-violet radiation and corpuscular energy that a flare gives off are beyond imagination! While we can intercept less than a billionth part of its total radiation in all directions into space, its effects indicate an astonishing quantity of power.

Large flares last longer than small ones and are more apt to cause a blackout of overseas radio communications. The smaller flares can be detected only by hydrogen filters used in telescopes. They are seen frequently in the solar-flare patrol work of a number of observatories. These flares appear without warning, constituting the greatest form of solar disturbance known. Within a few minutes they often spread out to cover an area of billions of square miles, sometimes lasting an hour.

Parts for solar-flare indicator

2—270,000-ohm ½-watt resistors; 1—25,000-ohm potentiometer; 1—.001 (disc), 1—1 (metallized paper), 1—1,000 µf (6-volt electrolytic), capacitors; 3—2N35 transistors; 1—1N34A diode; 1—coil (L1), 60–130 mh (J. W. Miller 6324 width-linearity coil or equivalent); 3—coils (L2, L3, L4), 50 mh, 110 ohms, 75 ma (J. W. Miller 6310 or equivalent); 2—1.5-volt size-D cells; 1—double cell holder; 1—output jack and insulating washers; 1—meter, 0–200 µamps; 1—dpst switch; 2—5-terminal barrier strips; 2—binding posts; 1—box.

Parts for alarm system

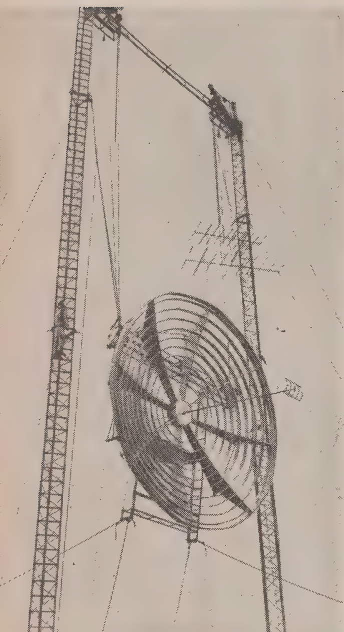
1—15,000-ohm potentiometer; 1—2N35 transistor; 1—phone jack; 1—22.5-volt battery; 1—filament transformer; 1—6-volt buzzer; 1—relay, 115 volts ac, 2 ma or less (Sigma 4F or equivalent).

The class-3-plus type of flare emits a spectrum of white light for a few minutes while the flare is at its brightest and can be seen with an ordinary telescope—when an observer happens to be watching at the time, which is rare. However, a solar-flare indicator detecting such an intense type of flare would be extremely useful so that it would be possible to know when to observe with an ordinary telescope.

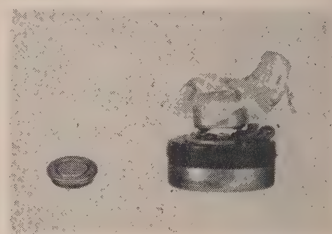
During the sunspot maximum of 1937, there were shortwave radio fadeouts of several days' duration. In that same year great magnetic storms and earth currents affected the cables under the ocean and the telephone and telegraph service over long lines as well. Sunspot magnetic polarities are the same on alternate sunspot cycles—approximately every 20 years. Since the sunspot magnetic polarities will be the same in 1957 as they were in 1937, it should prove very interesting to science and the radio industry to see what will happen during the coming sunspot maximum.

Those who would like to pursue the subject of sunspots and radio communications further are recommended to the new book *The Sun and Its Influence* by Dr. M. A. Ellison (Macmillan & Co.). END

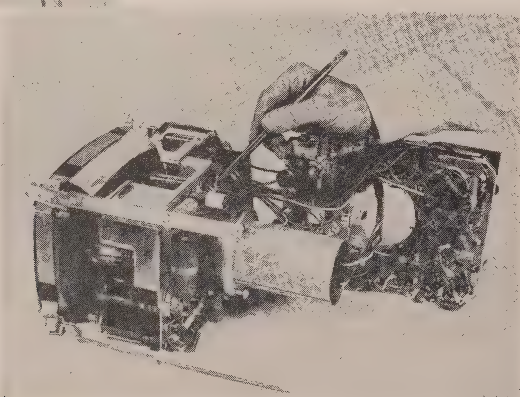
what's new?



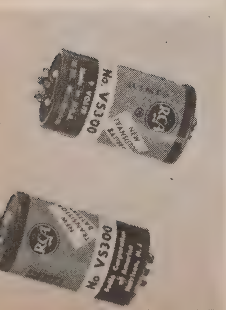
WORLD'S LARGEST antenna for receiving TV broadcasts may well be this 26-foot parabola at Ventnor, N. J. It was erected by Jerrold Electronics of Philadelphia for experiments in cooperation with the South Jersey Cable Co., a community antenna system serving Ventnor. Signals from the big dish are fed into the community antenna system and piped into subscribers' homes. The visible portion of the antenna is actually plywood and steel; the actual reflecting surface is of thin wire mesh. Signals are picked up by a folded dipole in the focus. A small reflector shields it from signals other than those from the parabola, thus maintaining sharp directivity. The antenna is so mounted that it can be tilted to take advantage of the horizontal propagation angle.



NOT A POTENTIOMETER, this little unit is a complete hearing aid, designed to fit into the ear. The mercury cell at left fits into the open space under the molded earpiece. There is no on–off switch; the aid is turned on by inserting the cell. Unlike some other ultraminiature hearing aids, this device does have a volume control. It is seen as a narrow light strip under the open space—actually the circular rim of the control. The arm can also be seen on close inspection. The volume control renders this aid suitable for cases of mild as well as moderate hearing impairment.



AN INSIDE VIEW of the RCA Victor personal portable TV described in schematic form on pages 48 and 49 of our June issue. Sliding the vertical chassis back and to the side gives a better view of the components mounted around the rectangular picture tube, as well as of the chassis bottom itself. The kinescope, an 8DP4, provides a 36-square-inch picture. The set uses a large proportion of multiple-purpose tubes and some interesting new circuitry, which permit the complement of 10 tubes (plus kinescope) 4 crystals, 1 tube rectifier and a double-purpose selenium rectifier to perform no less than 24 tube functions.



NEW 9-VOLT BATTERY that looks like a flashlight cell, the VS300 contains seven mercury cells, with a life, when used with transistor receivers, much longer than that of dry cells of many times their bulk. Like all mercury batteries, shelf life is very long compared with that of small dry cells, making this battery especially useful for transistor equipment intended for occasional use over long periods.

what test gear is needed?

What equipment is indispensable to the new service shop operator—what items merely convenient? This article gives the answer

By MATTHEW MANDL *
TELEVISION CONSULTANT

THE technician starting out in television and radio servicing is confronted with the problem of obtaining test instruments. Since few beginners can afford a complete line of test equipment, they usually purchase only the items most urgently needed and then add to them as their business grows. Hence, these questions are most often asked by the newcomer in the servicing field:

1. What equipment shall I buy first?
2. How much should I spend for each piece of test equipment?
3. Which equipment will be outmoded first?
4. Are kits worth building?
5. How difficult is it to use the equipment?
6. How often must worn-out equipment be replaced?

It is significant that these questions embrace only test equipment and not some of the other prerequisites for rapid troubleshooting. In addition to test equipment the technician needs a workbench and the mechanical aids of the trade—a soldering iron, pliers, cutters and other hand tools—as well as a general stock of resistors, capacitors, tubes, hookup wire and soldering lugs.

Thus, the newcomer should have a long-range project, not only with respect to the accumulation of test equipment, but also to the other accessories required, including radio components. It is time-consuming when trouble has been diagnosed but the receiver must be put aside until a trip is made to a parts distributor for capacitors or resistors.

The voltmeter

The most important and basic item necessary in a service shop is some sort of voltmeter, or rather a *multimeter* for flexibility in testing. Multimeters fall into three general categories: the multitester, the 20,000-ohms-per-volt meter and the vacuum-tube voltmeter.

The cheapest type multimeter, the so-called "multitester," usually uses a 1,000-ohms-per-volt meter movement and has a scale for reading direct current. It has serious limitations because of its low ohms-per-volt rating. While this instrument gives fairly accurate readings for many voltages, it will often load a circuit under test because of its low internal resistance. Thus, it is not useful for accurate measurements in many television circuits. A 1,000-ohms-per-volt meter, for instance, has a resistance of 5,000 ohms on its 5-volt scale and, if 5 volts is to be read across a 5,000-ohm resistor, inaccurate readings will be obtained. Since the meter resistance of 5,000 ohms shunts the resistor across which the voltage is read, the current through the resistor divides between itself and the meter resistance. Hence, only one-half the normal current flows in the resistor, and the voltage drop is about half the actual drop across the resistor under normal operating conditions.

The resistance range of the inexpensive multimeter is also limited, since resistance values above 50,000 ohms are on a very crowded scale and difficult to read. Hence, the resistance reading accuracy of this instrument is confined primarily to lower-value resistances and not useful for measurements in the megohm ranges.

The current-reading scale of the multitester is useful and in this respect it has an advantage over most vtvm's which do not generally include a current-reading circuit. Most experienced technicians, however, are reluctant to take current measurements when servicing receivers because this requires opening a circuit to insert the milliammeter.

The 1,000-ohms-per-volt tester, being relatively cheap, is often purchased as the initial piece of test equipment by the newcomer in the field. Unlike the vtvm, it is self-contained and does not need to be plugged into the ac line. Thus, though necessity demands the purchase of an inexpensive meter, such an instrument will still be useful even though one higher-priced is purchased later—it is portable and useful for continuity checking and checks voltages and resistances within its limitations.

The 20,000-ohms-per-volt meter

A better instrument, and one which falls midway in price between the multitester and the vtvm, is the 20,000-ohms-per-volt meter. Its basic microammeter movement is more sensitive and the voltmeter circuit presents a much higher impedance when making voltage checks. Hence, there is much less loading effect with the 20,000-ohms-per-volt meter as compared to the 1,000-ohms-per-volt unit (a ratio of 20 to 1). On the 500-volt scale, for instance, this meter has a resistance of 10 megohms as compared to only 500,000 ohms for the cheap multitester. For higher voltage scales, it actually has a higher input resistance than the vacuum-tube voltmeter.

The vtvm

The vacuum-tube voltmeter is the most popular instrument in use among service technicians. It has an input impedance of approximately 10 megohms which remains constant for any voltage scales used and hence has negli-

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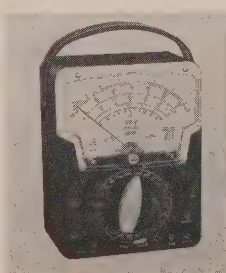

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1—Triplett model 631 is a combined vacuum-tube voltmeter and volt-ohm meter.

2—Philco 8300 oscilloscope amplifier.

3—Tripplett Model 3441 oscilloscope.

gible loading effect for reading voltages across most resistors found in television and radio receivers. It is also superior to other multimeters with respect to its ohmic range, giving fairly accurate readings up to 1,000 megohms. The primary disadvantage is that it has to be plugged into the ac line. (It is now possible to buy several completely portable battery-operated vtvm's.—*Editor*) A secondary disadvantage is, perhaps, the absence of a milliammeter scale in most of these.

The average- or medium-priced vtvm uses the vacuum-tube voltmeter principle on only the dc scale, with the ac scale usually consisting of an ordinary ac voltmeter. Higher-priced instruments can be purchased, however, which also use the vacuum-tube voltmeter principle in the ac voltage ranges.

If the technician has enough money to purchase the more expensive type, it would be preferable to do so. If, however, the lower-priced vtvm is bought, the lack of the vtvm principle on the ac scale need not concern him too much, because the instrument will still have many more applications than would an ordinary multitester. A vtvm capable of reading peak-to-peak voltages for an analysis of TV waveforms is useful, but can be foregone temporarily if enough money is not available. Peak-to-peak voltages can be read with an oscilloscope, since the latter can be calibrated.

All the multimeters discussed have a long, useful life and there is little chance of their being outmoded. Accessories for extending the range of the instrument can be acquired after the instrument has been purchased. A high-voltage probe, for instance, is useful for checking the second-anode voltages of television receivers. When a probe is purchased, it should be one which extends the voltage range of the meter to at least 30,000 so that the second-anode voltages of color television receivers can be checked. Diode probes can also be acquired, permitting the instrument to be used for measuring rf voltages, which also makes it useful for rf signal tracing.

Tube checkers

The second most important item to be acquired is a tube checker. There are two general types of tube checkers: emission and transconductance. The latter will evaluate a tube's characteristics more accurately but is more expensive. The emission type will, however, give a fairly good evaluation of performance for more than 90% of tubes.

It has been my experience that a tube checker should not always be relied upon completely since it does not subject the tube to the operating potentials and signal frequencies as those encountered in actual circuitry. If there is any doubt regarding the reliability of a given tube, a new tube, known to be good, should be substituted for the suspected one.

Tube checkers *are* useful for giving an immediate indication of whether a filament is open and whether the emission (or transconductance) falls within an acceptable range.

Unlike the multimeters, the tube checker becomes outmoded within a short interval because of the constant stream of new tube types manufactured. The better tube-checker manufacturers furnish new roll charts to update testers. When purchasing a tube checker, the technician should ascertain whether the manufacturer has established such a policy.

The emission type tube checker, being less expensive than the transconductance kind, has been purchased in greater numbers. If the newcomer can afford the additional cost of the transconductance type, it should be preferred.

The oscilloscope

The oscilloscope is a most useful tool for troubleshooting and analyzing television receivers and should be the third item on the new service technician's list. If, however, the newcomer to the servicing field initially intends to service such items as radios, record changers, etc., but not TV receivers, he can dispense with the oscilloscope and instead get a signal generator—normally the fourth important item for the TV technician.

Oscilloscopes come in a variety of models, ranging from the very inexpensive kits to the extremely high-priced laboratory instruments. The oscilloscope, because it gives a visual indication of the signal waveform in a circuit, is extremely useful in signal tracing, observing waveform defects and making peak-to-peak voltage readings.

The degree of flexibility built into an oscilloscope is related directly to its cost. If an oscilloscope has a high degree of sensitivity, as well as operating at very high video frequencies, the cost will be much higher than one of more limited ability.

Virtually all oscilloscopes check television sweep waveforms, since only 60 and 15,750 cycles are involved. The accuracy of the reproduced waveform, however, depends on the frequency response of the oscilloscope because of the harmonic content of the waveforms involved. Sawtooth and rectangular waveforms have harmonic frequencies ranging up to the 10th and 15th harmonics. If these upper frequencies are not reproduced faithfully, the waveshape indicated on the face of the scope will not be a true representation of the actual waveshape in the circuit.

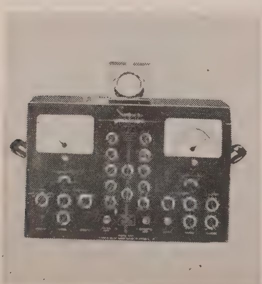
With the growth of color television, it will be increasingly necessary for the oscilloscope to be capable of testing waveforms having frequencies up to 4 mc. (The burst frequency is 3.58 mc and it will often be desirable to ascertain whether this burst frequency is present in the color-burst afc system.

If a more expensive unit cannot be bought, the technician will still find that inexpensive oscilloscopes save considerable time and are a big help in troubleshooting. If at a later date a more expensive scope is desired, the lower-priced oscilloscope can be traded in for a better one or it can be modified by rewiring the circuits.

Often manufacturers make available accessories which can improve the instrument or extend its range, just as with the diode probes and high-voltage probes available for vtvm's. A limited-frequency-range oscilloscope can also be improved in this manner by using the accessory manufactured by Philco, known as the model 8300 Wideband Oscilloscope Amplifier. This device replaces the vertical amplifier of a low-priced scope and extends its range for a frequency response of from 20 cycles to 4.5 mc.

Signal generators

The fourth most important item in terms of acquisition is an rf signal generator, useful for alignment as well



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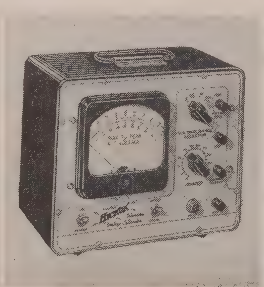

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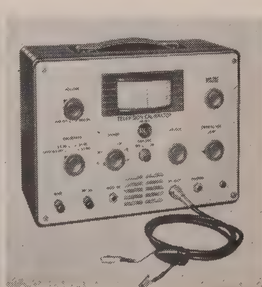

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as being a signal source for signal tracing. If servicing is confined to radios, an inexpensive signal generator can be bought which will cover only the if and rf ranges involved in radio reception. But since it is almost a certainty that the beginner who starts out with just radio servicing will eventually go into TV, it would be preferable to acquire a signal generator which can be used for both.

In signal generators, the most important consideration is accuracy. Unless the signal generator can be calibrated accurately, its usefulness for alignment purposes will be impaired. A signal generator which produces a single signal is useful in television repairs not only for signal tracing, but also for producing a marker; in this application it is used in connection with a sweep generator. A sweep generator permits observing the overall bandpass characteristics of rf or if amplifiers and the marker generator indicates the exact frequency at any particular point along such a response curve. The sweep generator should have a substantial flat output for its entire sweep range! Accuracy of frequency in the sweep generator is not important. The marker generator takes care of rf or if alignment accuracy.

Since both the single-signal and sweep generators are necessary for expediting alignment, both will eventually have to be acquired. Initially, however, the single-signal or marker generator can be purchased.

If color television servicing is to be undertaken, the eventual purchase of a color bar generator as well as a dot–bar generator is strongly recommended. The color bar generator will aid in checking and aligning the color circuits of a television receiver; the dot–bar generator aids in establishing the proper convergence and vertical and horizontal picture linearity. Since the NTSC color system is now the accepted standard, the generators acquired for servicing color receivers should run little danger of being outmoded in the foreseeable future.

The dot–bar generator can also be used for linearity adjustments of black-and-white receivers. Cross-bar generators are available for use exclusively with black-and-white receivers, but their purchase is not recommended for the initial test equipment collection. It is better to wait until a dot–bar generator can be procured because it is not only useful for linearity alignment on black-and-white receivers but can also be used for convergence and linearity adjustments in color receivers.

Until the time such a generator is obtained, severe cases of nonlinearity in television receivers can be adjusted by judging the general appearance of objects in the scene as the linearity controls are adjusted. (A fairly accurate adjustment of the vertical linearity can be made by throwing the vertical hold slightly off until the picture rolls. Then observe the blanking bar as it moves up or down the picture. The linearity is adjusted until the bar has the same thickness as it rolls up the screen. If the bar is thicker at the bottom of the screen than at the top (or vice versa), it indicates incorrect vertical linearity. Adjusting the height as well as the vertical linearity control will usually result in fairly satisfactory vertical linearity. If the drive control is adjusted right below the point where left-hand stretch or center compression occurs, horizontal linearity will be satisfactory after the picture has been adjusted to just fill the mask horizontally.)

Other generators, on occasion, find useful applications in servicing. The audio signal generator, for example, can be used for signal tracing in the audio amplifier stages of receivers and audio systems. Some rf signal generators have an external connection whereby the 400-cycle frequency is available for test purposes. The audio signal generator is useful, however, where additional frequencies are required for frequency-response checks and other related work.

Audio generators which have a square-wave as well as a sine-wave output will be found more useful since the availability of a square wave is of some use in signal substitution practices in TV sweep-circuit servicing.

Capacitor checker

A capacitor checker is a useful instrument since both the capacitance and leakage (power factor) of a suspected bypass, coupling or filter capacitor can be evaluated immediately. Because the capacitor checker usually is less expensive than some of the other equipment, it can be purchased at any time the money is available.

Many service technicians dispense with a capacitor checker and replace any capacitors which indicate an appreciable leakage as determined by an ohmmeter check. If an ohmmeter check fails to disclose the trouble, a new capacitor is substituted. There is no question, however, that a capacitor checker will save time and give a more reliable test than otherwise possible.

Test equipment kits

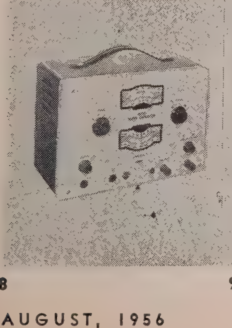
Several companies produce a variety of test equipment which comes unassembled and must be constructed by the purchaser. Such kits, of course, cost much less than the completely wired and assembled versions and hence afford a considerable saving to the technician who has time to build his own equipment. For the most part, such test equipment is of excellent design and many thousands of kits have been giving excellent service for many years.

By assembling these units, the technician becomes familiar with the circuitry of the equipment as well as the physical layout on the chassis. Hence, he is in a better position to service the test equipment when trouble occurs.

When such kits are properly constructed, they perform as well and as efficiently as the prewired units available from wholesale houses. Virtually all kits come with exceptionally clear and complete wiring instructions giving both schematic and layout versions of the complete unit. Printed circuit boards in most of the newer kits save considerable time in wiring up the unit.

Perhaps the only disadvantage with the completed kit is that it has less trade-in value than a standard-name product. Other than this minor drawback, however, the kits offer some excellent pieces of test equipment at a price considerably lower than for a completed item. Since many kit manufacturers have several models available for any particular item, the purchaser can select the one which gives him the most usefulness for his money.

Another advantage of instruments in kit form is that they may be assembled during periods when business is slow. Thus servicing time is not lost and dead periods are made productive. END



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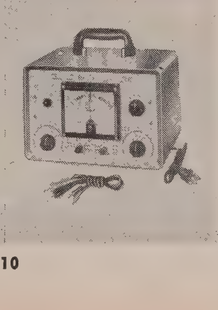

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4—Simpson Genescope, model 480, combines AM marker generator with crystal calibrator, FM generator and oscilloscope.

5—Hickok 630 TV voltage calibrator.

6—RCA WR-39C TV calibrator—instrument can be used as a marker generator.

7—Hickock model 695 sweep generator.

8—The RCA WA-44A audio signal generator.

9—Philco color bar and dot bar generator.

10—Simpson 383 capacitor leakage tester.

Two-Way Instrument Checks TV's and Radios

Semiminiature device is both af-rf signal tracer and af signal generator

By JOHN POTTER SHIELDS

PROVIDING a number of useful functions around the service shop or home workshop, this unit is a combined af–rf signal tracer and af signal generator in a small case which fits in a coat pocket. The unit is entirely self-contained. It's only source of operating power is a small 15-volt hearing-aid type battery which will last just for about its shelf life.

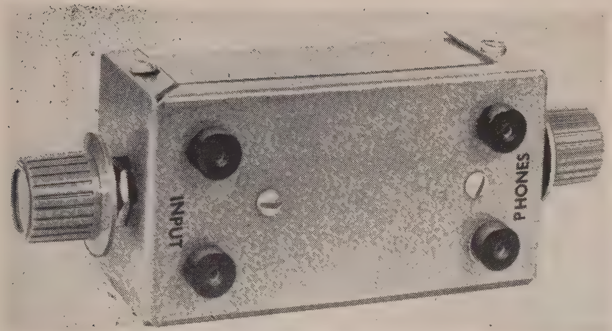
The device (see diagram) contains a single 2N107 p-n-p transistor used as a single-stage grounded-emitter amplifier. A subminiature transformer (Stancor UM-110) couples the amplified signal in the 2N107 collector circuit to an external load such as a pair of headphones. This transformer performs another important function: When the selector switch is thrown to the signal-injector position, the transformer secondary is switched into the 2N107 base circuit, making the entire circuit an audio-frequency oscillator. In this case, the generated audio voltage appears across the PHONES terminals. When the selector switch is thrown to the signal-trace position, the base of the 2N107 is switched from the transformer secondary to the input terminals. The unit can now be used as an audio signal tracer. An external crystal diode, such as a type 1N34, can be placed in series with the hot input terminal to turn the unit into an rf signal tracer useful for following a signal through the rf sections of a receiver.

The instrument can also be used as a code-practice oscillator by placing a key in series with the phone leads and switching the unit to the signal-injection position.

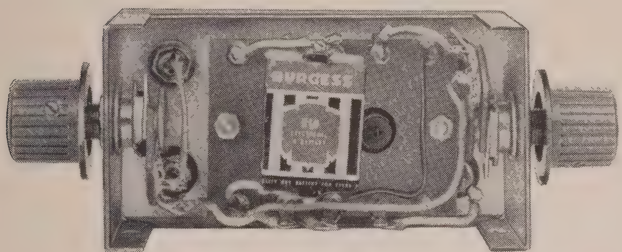
The entire unit was built into a standard Bud Minibox which measured 5 x 2¼ x 2¼ inches. Most of the circuit components were placed on a fiber mounting board which was mounted on ½-inch standoffs inside the box.

To conserve space a subminiature transformer was used. It was easily mounted on the underside of the fiber mounting board with a drop of Duco

Servicing a TV set with this versatile device.



Device has neat, balanced appearance.

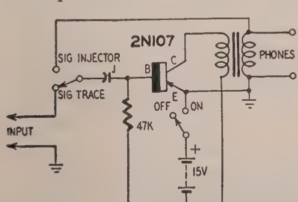


Internal construction of the unit.

cement and its leads soldered directly to the various components. A cheaper, but somewhat larger, transformer such as the UTC SO-3 will work just as well. I found that a standard "garden-variety" output transformer would work properly in this circuit.

The battery can be easily mounted by two stiff wires directly attached to its terminals. Due to the extended battery life it was felt that a battery holder would just take up space and add to the cost of the unit. Be sure to observe proper battery polarity. While I used a 15-volt battery, the unit will operate properly on a battery voltage as low as 3. Other transistors such the the types CK721, CK722, 2N34, etc., will be just as satisfactory.

A transistor socket was used in the construction of the original model, but the transistor can be soldered directly into the circuit. However, there are several advantages in using sockets to mount transistors. First, they can be easily inserted and removed from the circuits. Second, sockets protect the transistor from excessive heat during soldering, as the transistor need not be installed until all connections have been made to the socket. Third, if sockets are used, the rather fragile leads of the transistor will not be damaged by continually being soldered into and removed from various experimental setups. If soldered directly into the circuit, the leads should be kept at least ½ inch long and held tightly with a pair of long-nose pliers when being soldered. The pliers act as a heat sink, conducting heat away from the transistor.



Schematic diagram of the instrument.

Once the unit is finished it is a simple matter to get it operating properly: Set the selector switch to the signal-injector position and connect a set of phones to the PHONES terminals. If all is in order a tone should be heard in the phones. If no tone is heard, it means probably that the transformer windings are not properly phased. To correct this, simply reverse either the primary or secondary connections to the transformer. Since the circuit is not at all critical with respect to components, no other trouble should be encountered.

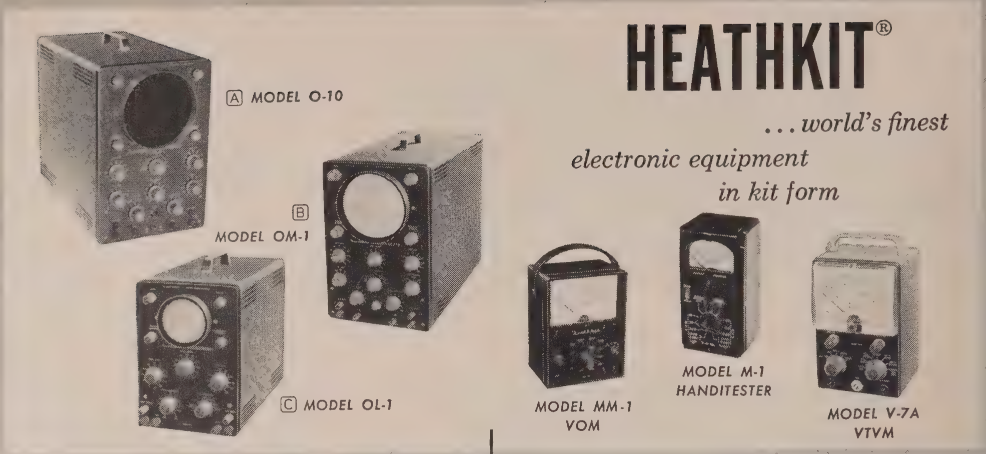
When used as a signal tracer, this device will trace an audio signal through the audio and detector stages of a radio or TV receiver. For example, it is necessary merely to ground the common input probe to the set being checked, and then touch the hot probe to the grid and plate of the suspected stage. As the hot probe is moved from grid to plate, the signal should increase. If a signal is heard on the grid but not on the plate of the stage, some component in the stage is defective. The same procedure can be followed to determine if the sweep circuits of a TV receiver are functioning properly.

By adding a crystal diode to the input of the device, it can be used to trace an rf signal through a receiver. If desired, the crystal diode can be permanently wired with a switch to throw it in or out of the circuit.

This instrument can also be used to inject a signal into a circuit under test. In this case its output can be fed into a receiver, starting at the plate of the output tube, and working back until the signal is lost. In this manner, the faulty stage can be isolated. END

Parts for versatile checker

1—47,000-ohm ½-watt resistor; 1—0.1-μf capacitor; 1—2N107 transistor; 1—15-volt hearing aid battery; 1—transformer, primary impedance 20,000 ohms, secondary 1,000 ohms (Stancor UM-110 or equivalent); 1—spdt switch; 1—spst switch; 4—insulated tip jacks; 1—small box (Bud Minibox CU-2104 or equivalent; 1—mounting board.



A *Heathkit* **ETCHED CIRCUIT** COLOR TV

5″ OSCILLOSCOPE KIT

Amplifier response essentially flat (+2 db −5 db) from 5 mc down to 2 cps without extra switching. Sweep oscillator allows single-cycle observation up to 500,000 cps, and will sync signals even higher. Uses etched metal circuit boards. Push-pull vertical and horizontal amplifiers—built in peak-to-peak calibrating source—step attenuated input—preformed and cabled wiring harness. A professional scope ideal for color TV work in the lab or service shop. 11-tube circuit features 5UP1 CRT.

MODEL O-10
$69.50
Shpg. Wt. 21 Lbs.

B *Heathkit* **ETCHED CIRCUIT**

5″ OSCILLOSCOPE KIT

The OM-1 has many big scope features, including 5″, 5BP1 cathode ray tube, and yet it is priced reasonably. Features etched metal circuit boards. Incorporates 3 step input attenuator—phasing control—built-in peak-to-peak voltage calibrator—and push-pull vertical and horizontal amplifiers. Vertical amplifier flat within ±3 db from 2 cps to 200 kc. Sweep circuit functions from 20 cps to 100,000 cps. An excellent general purpose scope for service shop or lab.

MODEL OM-1
$49.50
Shpg. Wt. 21 Lbs.

C *Heathkit* **ETCHED CIRCUIT**

3″ OSCILLOSCOPE KIT

Has many of the features of the Model OM-1, yet is smaller in physical size for portability, and for use in the home workshop. Employs etched metal circuit boards. Vertical frequency response within ±3 db from 2 cps to 200 kc. Sweep generator operates from 20 to 100,000 cps. The 8-tube circuit features a type 3GP1 cathode ray tube. Measures only 9½″ h. x 6½″ w. x 11¾″ d.

MODEL OL-1
$29.50
Shpg. Wt. 14 Lbs.

Heathkit **20,000 OHMS/VOLT**

VOM KIT

Requires no external power. Sensitivity is 20,000 ohms/v. DC and 5,000 ohms/v. AC. Black Bakelite case—4½″ 50 ua. meter—1% precision resistors. AC and DC ranges are 0-1.5 5, 50, 150, 500, 1500, and 5000 volts. Direct current ranges are 0-150 ua., 15 ma., 150 ma., 500 ma., and 15 a. Resistance multipliers are X1, X100, and X10,000. DB range from −10 db to +65 db. Especially valuable in portable applications.

MODEL MM-1
$29.50
Shpg. Wt. 6 Lbs.

Heathkit HANDITESTER KIT

This compact model easily slips into tool box, glove compartment, or coat pocket. Valuable as "extra" instrument in service shop, and ideal for the home experimenter. Very popular with appliance repairmen, and electricians. Measures AC or DC voltage at 0-10, 30, 300, 100, and 5000 volts. Direct current ranges are 0-10 ma., and 0-100 ma. Attractive black Bakelite case.

MODEL M-1
$14.50
Shpg. Wt. 3 Lbs.

Heathkit **ETCHED CIRCUIT VACUUM TUBE**

VOLTMETER KIT

The V-7A is used in scientific laboratories, technical schools, service shops, ham shacks, and in the home workshop. Features 200 ua. meter, 1% precision resistors, and etched metal circuit board. Measures DC voltage, ACV (rms), AVC (peak-to-peak), and resistance. AC (rms) and DC voltage ranges are 0-1.5, 5, 15, 50, 150, 500, and 1500 volts. Peak-to-peak ranges are 4, 14, 40, 140. 400, 1400, and 4000 volts. Ohmmeter ranges provide multipliers of X1, X10, X100, X1000, X10K, X100K, and X 1 megohm. DB scale also provided. 11 megohm input impedance.

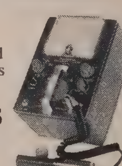
MODEL V-7A
$24.50
Shpg. Wt. 7 Lbs.

NEW *Heathkit* PROFESSIONAL RADIATION COUNTER KIT

- *Modern circuit design for maximum sensitivity and reliability.*
- *Employs 900 volt Bismuth tube in beta/gamma sensitive probe.*
- *Both visual and aural indicators for radiation level.*

This radiation counter features ranges of 0-100, 600, 6000, and 60,000 counts per minute and 0-.02, .1, 1, and 10 milliroentgens per hour. The probe uses a 6306 Bismuth tube. The 5-tube circuit employs a 4½″, 200 ua. meter, calibrated in cpm, and mR/hr. Also aural signal provided from panel-mounted speaker. Simple to build from the instructions supplied, even for a beginner.

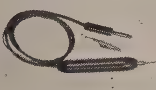
MODEL RC-1
$79.95
Shpg. Wt. 8 Lbs.



HEATH COMPANY A Subsidiary of Daystrom, Inc. **BENTON HARBOR 20, MICH.**

Heathkit PROBE KITS

ETCHED CIRCUIT RF
No. 309-C. $3.50
Shpg. Wt. 1 Lb.
Use with any 11 megohm VTVM for RF measurements up to 250 mc with ±10% accuracy. Employs etched circuit.

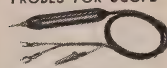


ETCHED CIRCUIT PEAK-TO-PEAK
No. 338-C. $5.50
Shpg. Wt. 2 Lbs.
Use to read peak-to-peak voltages on DC scale of 11-megohm VTVM. Read direct on VTVM scales from 5 kc to 5 mc.

30,000 VOLT D.C. HIGH VOLTAGE
No. 336. $4.50
Shpg. Wt. 2 Lbs.
Use to measure high DC voltage with VTVM. Precision multiplier resistor mounted inside plastic probe. Multiplication factor of 100 on Heathkit 11-megohm VTVM.

PROBES FOR VTVM

PROBES FOR SCOPE



LOW CAPACITY
No. 342. $3.50
Shpg. Wt. 1 Lb.
Low capacity probe prevents circuit loading. Features variable capacitor for correct impedance matching. Ratio of attenuation can be controlled.

SCOPE DEMODULATOR
No. 337-C. $3.50
Shpg. Wt. 1 Lb.
This probe functions like detector to pass only modulation of signal, and not signal itself. Applied voltage limits are 30 volts rms, and 500 VDC.

Heathkit ELECTRONIC SWITCH KIT

This instrument allows simultaneous oscilloscope observation of two input signals by producing both signals, alternately, at its output. All-electronic circuit provides 4 switching rates, selected by panel switch. Provides gain for input signals, and features frequency response of ±1 db 0-100 kc. Employs seven miniature tubes. Sync output provided to control scope sweep. Functions at signal levels as low as 0.1 volt.

MODEL S-3
$21.95
Shpg. Wt. 8 Lbs.

Heathkit VARIABLE VOLTAGE REGULATED POWER SUPPLY KIT

This power supply provides regulated DC output that can be manually controlled from 0 to 500 volts. Supplies up to 130 ma at 200 VDC, and up to 10 ma at 450 VDC. Large panel meter monitors output voltage or current. Supplies filament voltage at 6.3 volts AC (4 amperes). Filament and B+ circuits isolated from ground. Ideal lab power supply for use in experimental work.

MODEL PS-3
$35.50
Shpg. Wt. 17 Lbs.

Heathkit ISOLATION TRANSFORMER KIT

Provides isolation between the power line and equipment under test. No direct connection between primary and secondary. Keeps chassis of AC-DC sets "cold." Fused in the primary circuit. Also provides manual voltage control from 90 volts to 130 volts for test purposes. Rated at 100 volt-amperes continuously. Panel meter monitors output voltage.

MODEL IT-1
$16.50
Shpg. Wt. 9 Lbs.

Heathkit DIRECT READING CAPACITY METER KIT

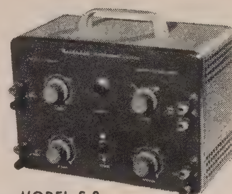
This unique instrument indicates capacity in mmf, or mfd, directly on a 4½" 50 ua. meter. Ranges are 0 to 100 mmf, 0-1000 mmf, 0-.01 mfd, and 0-.1 mfd. Residual capacity less than 1 mmf. Scales are linear. Instrument not susceptible to hand capacity effects. Will measure even small value trimmers or variable air capacitors.

MODEL CM-1
$29.50
Shpg. Wt. 7 Lbs.

Heathkit VIBRATOR TESTER KIT

Checks condition of vibrators under operating conditions. Tests 6-volt vibrators only. Use in conjunction with BE-4 battery eliminator, or similar variable power source. Indicates vibrator quality on large "good-bad" scale. Tests both interrupter and self-rectifier types. 5 different sockets.

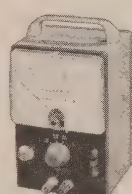
MODEL VT-1
$14.50
Shpg. Wt. 6 Lbs.



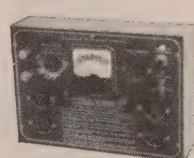
MODEL S-3
ELECTRONIC SWITCH KIT

MODEL PS-3
VARIABLE VOLTAGE
REGULATED
POWER SUPPLY KIT

MODEL IT-1
ISOLATION
TRANSFORMER KIT



MODEL CM-1
CAPACITY
METER KIT



MODEL VT-1
VIBRATOR TESTER KIT

Photographers! *Heathkit* ENLARGER TIMER KIT

Use to time photographic enlarger. "Time" dial allows settings of from 5 to 60 seconds. Will also control safe-light "on" when enlarger is "off." Enlarger and safelight plug into recepticals on front panel. Handles up to 350 watts. Ideal device to free operator for other operations, and very simple to build. Compact plastic case.

MODEL ET-1
$11.50
Shpg. Wt. 3 Lbs.

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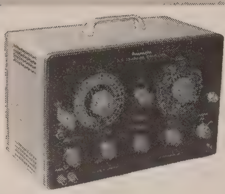
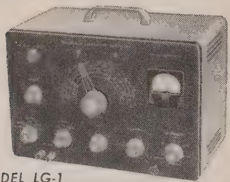


MODEL TS-4
TV SWEEP GENERATOR KIT



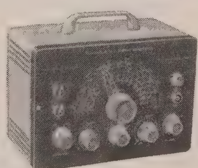
MODEL LG-1
LABORATORY GENERATOR KIT

HEATHKIT®

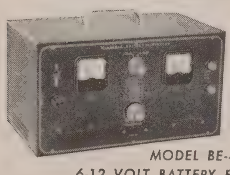
instruments

CONTAIN HIGH QUALITY COMPONENTS THROUGHOUT. EACH AN OUTSTANDING DOLLAR VALUE IN TEST EQUIPMENT.

MODEL LP-2
LINEARITY PATTERN GENERATOR KIT



MODEL SG-8
RF SIGNAL GENERATOR KIT



MODEL BE-4
6-12 VOLT BATTERY ELIMINATOR KIT

Heathkit TV SWEEP GENERATOR KIT

All-electronic sweep circuit eliminates mechanical hum and vibration. Features improved linearity—effective AGC—flat output—0 to 40 mc sweep. Covers all frequencies for black and white or color TV work, as well as FM. High output for alignment of tuners, IF strips, boosters, etc. Fundamental output from 4 to 220 mc in four bands. Has crystal oscillator (4.5 mc and multiples thereof), and variable marker covering 19 to 60 mc—up to 180 mc on harmonics. Provision for external marker. Effective two-way blanking.

MODEL TS-4
$49.50
Shpg. Wt. 16 Lbs.

Heathkit LABORATORY GENERATOR KIT

This signal generator covers from 100 kc to 30 mc on fundamentals in 5 bands. 400 cycle modulation variable from 0 to 50%. RF output up to 100,000 microvolts. Meter reads RF output or percentage of modulation. Fixed step and variable output attenuation. Voltage regulation, double copper-plated shielding for stability, and other "extras." Provision for external modulation. Output impedance 50 ohms.

MODEL LG-1
$39.50
Shpg. Wt. 16 Lbs.

Heathkit LINEARITY PATTERN GENERATOR KIT

Supplies information for white dots, cross-hatch pattern, horizontal bar pattern, or vertical bar pattern. Use for adjustment of vertical and horizontal linearity, picture size, aspect ratio, and focus. Dot pattern is a *must* for color convergence adjustments. Clip merely connects to antenna terminals of TV set. Panel provision for external sync if desired. Covers channels 2 to 13. 5 to 6 vert. bars and 4 to 5 hor. bars.

MODEL LP-2
$22.50
Shpg. Wt. 7 Lbs.

Heathkit SIGNAL GENERATOR KIT

This tried and proven generator covers 160 kc to 110 mc on fundamentals in five bands, and calibrated harmonics extend to 220 mc. Very popular in service shops, laboratories, and home workshops. RF output is in excess of 100,000 microvolts, controlled by a variable and a fixed-step attenuator. Output is pure RF, RF modulated at 400 cps, or 400 cps audio for amplifier testing.

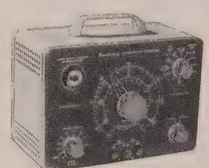
MODEL SG-8
$19.50
Shpg. Wt. 8 Lbs.

Heathkit BATTERY ELIMINATOR KIT 6-12 volt

This up-to-date battery eliminator will supply either 6 or 12-volt output to take care of auto radios from even the most modern automobiles. Output voltage is variable 0-8 volts DC or 0-16 volts DC. Will deliver up to 15 amperes at 6 volts or up to 7 amperes at 12 volts. Two 10,000 microfarad output filter capacitors insure smooth DC output. Panel meters monitor output current. Will double as a battery charger. Definitely required for automobile radio service work.

MODEL BE-4
$31.50
Shpg. Wt. 17 Lbs.

Heathkit CONDENSER CHECKER KIT



Measures paper, mica, ceramic, and electrolytic capacitors in 4 ranges from .00001 to 1,000 microfarads. Indicates condenser value and quality. Also measures resistance from 100 ohms to 5 megohms. All values indicated directly on panel scale, after adjusting for null on electron beam "eye" tube. No calculations necessary. A valuable instrument in service or laboratory applications.

MODEL C-3
$19.50
Shpg. Wt. 7 Lbs.

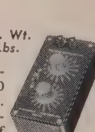
Heathkit SUBSTITUTION BOX KITS

Model CS-1 **$5.50** *Shpg. Wt. 2 Lbs.*

This unit provides switch selection of capacitor values from .001 mfd. to .22 mfd, in 18 RTMA standard values. Kit includes 18" flexible leads with alligator clips.

Model RS-1 **$5.50** *Shpg. Wt. 2 Lbs.*

Provides switch selection of resistances from 15 ohms to 10 megohms, in 36 RTMA values. Resistors are 1 watt, 10%. Extremely valuable in all types of electronic activity.



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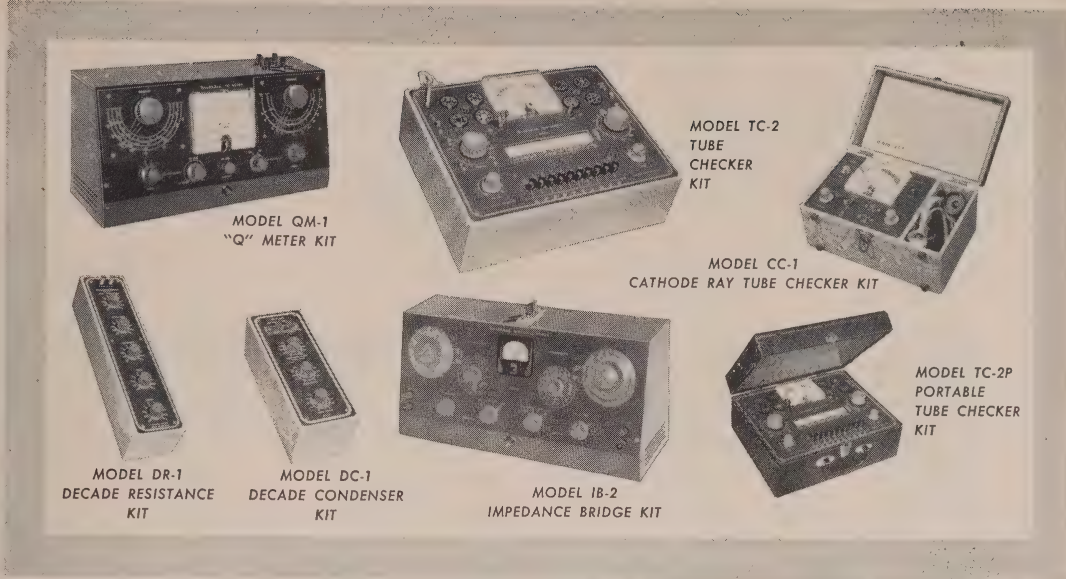


Heathkit "Q" METER KIT

The model QM-1 measures the Q of inductances and the RF resistance and distributed capacity of coils. Employs a 4½" 50 microampere meter for direct indication. Features built-in signal source for tests at frequencies of 150 kc to 18 mc in four ranges. Measures capacity from 40 mmf to 450 mmf within ±3 mmf. Indispensable for coil winding, and determining unknown capacitor values. A worthwhile addition to the laboratory or ham shack at a very low price.

MODEL QM-1 **$44.50** Shpg. Wt. 14 Lbs.

Heathkit DECADE RESISTANCE KIT

Provides 20 1% precision resistors that are switched to provide values from 1 to 99,999 ohms, in 1-ohm steps. High quality components for precision lab work.

MODEL DR-1 **$19.50** Shpg. Wt. 4 Lbs.

Heathkit DECADE CONDENSER KIT

Employs high precision 1% silver-mica capacitors for switch selection of values from 100 mmf to 0.111 mfd. in steps of 100 mmf. Employs ceramic switches for reduced leakage. Invaluable in the laboratory.

MODEL DC-1 **$16.50** Shpg. Wt. 3 Lbs.

Heathkit IMPEDANCE BRIDGE KIT

This bridge features built-in oscillator and amplifier. Measures resistance, capacitance, inductance, dissipation factors of condensers, and storage factor of inductance. D, Q, and DQ functions combined in one control. Employs ½% resistors and ½% silver-mica capacitors. 100-0-100 ua. meter indicates null. Two-section CRL dial provides ten separate "units" with accuracy of .5%. Fractions of units read on variable control.

MODEL IB-2 **$59.50** Shpg. Wt. 12 Lbs.

Heathkit TUBE CHECKER KIT

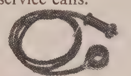
You can afford your own tube tester, even if you are an experimenter, or only do part time service work. Uses a 4½" meter with 3-color meter face for simple "good-bad" indications of tube quality, on the basis of emission. Will test all tubes commonly encountered in radio and TV service work. 14 different filament voltage values provided. Built-in roll chart—ten 3 position lever switches for open or short tests on each tube element. Space provided for future socket addition.

MODEL TC-2 **$29.50** Shpg. Wt. 12 Lbs.

Heathkit PORTABLE TUBE CHECKER KIT

The Model TC-2P is identical to the Model TC-2 except that it is housed in a rugged carrying case. This two-tone case is finished in proxylin impregnated fabric. The cover is detachable, and the hardware is brass plated. Ideal for home service calls.

MODEL TC-2P **$34.50** Shpg. Wt. 15 Lbs.



Heathkit TV PICTURE TUBE TESTER ADAPTER

MODEL 355 **$4.50** Shpg. Wt. 1 Lb.

Use with TC-2. Tests picture tubes for emission and shorts. 12-pin socket, 4 ft. cable, octal connector, and technical data. Not a kit.

Heathkit CATHODE RAY TUBE CHECKER KIT

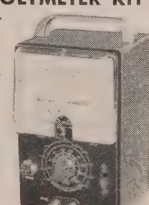
Indicates condition of CRT on large "good-bad" scale. Spring-loaded switches protect operator. Checks all electro-magnetic deflection picture tubes normally encountered in TV servicing. Housed in portable case for service calls. Supplies all operating potentials. Tests for shorts, leakage, and emission. Checks tubes on the work bench, in the carton, or in the set. Features shadowgraph test (spot of light on the screen).

MODEL CC-1 **$22.50** Shpg. Wt. 10 Lbs.

Heathkit AC VACUUM TUBE VOLTMETER KIT

Here is a VTVM designed especially for audio work. Combines high impedance, wide frequency range, and high sensitivity. Frequency response, substantially flat from 10 cps to 50 kc. Sensitivity allows measurements as low as 1 mv at high impedance. Ranges are .01, .03, .1, .3, 1, 3, 10, 30, 100, and 300 volts rms. Total db range −52 to +52 db. 1 megohm input impedance at 1 kc.

MODEL AV-2 **$29.50** Shpg. Wt. 5 Lbs.



HEATH COMPANY A Subsidiary of Daystrom, Inc. **BENTON HARBOR 20, MICH.**

Heathkit HARMONIC DISTORTION METER KIT

Designed for use with low distortion audio generator, (such as the Model AG-9). Measures harmonic distortion of audio amplifiers under a variety of conditions. Reads distortion on meter as percentage of input signal. Operates between 20 and 20,000 cps. High impedance VTVM built in for initial reference settings and final distortion readings. VTVM ranges are 0-1, 3, 10, and 30 volts full scale. 1% precision resistors employed. Distortion scales are 0-1, 3, 10, 30, and 100% full scale.

MODEL HD-1
$49.50
Shpg. Wt. 13 Lbs.

Heathkit CRYSTAL RECEIVER KIT

This crystal radio covers standard broadcast band (540 to 1600 kc). Employs two high-Q tank circuits. A sealed germanium diode is used for detection—no critical "cat's whisker" adjustment. Kit includes pair of high impedance headsets, and is easy to build, even for a beginner. Requires no external power.

MODEL CR-1
$7.95
Shpg. Wt. 3 Lbs.

Heathkit AUDIO GENERATOR KIT

Low distortion audio generator (less than .1%). Ideal for use with Model HD-1, or in other applications requiring low signal distortion. Frequency accuracy within ±5%. Features step-type tuning from 10 cps to 100 kc, with three rotary switches that provide two significant figures and a multiplier. Output monitored on large 4½" meter. Meter calibrated for output voltage or db. Output ranges are 0-.003, .01, .03, .1, .3, 1, 3, and 10 volts.

MODEL AG-9
$34.50
Shpg. Wt. 8 Lbs.

Heathkit AUDIO GENERATOR KIT

This generator covers from 20 cps to 1 mc in 5 ranges. Output constant within ±1 db from 20 cps to 400 kc, and down only 3 db at 600 kc. Produces good sine wave with distortion percentage below .4% from 100 cps through the audio range. Provides 10 volts output under no load conditions. Has continuously variable and step-type attenuator with settings of 1 millivolt, 100 millivolts, 1 volt, and 10 volts. Cathode follower output.

MODEL AG-8
$29.50
Shpg. Wt. 11 Lbs.

Heathkit AUDIO OSCILLATOR KIT

(Sine Wave—Square Wave)

Produces sine wave or square wave signals from 20 to 20,000 cps in 3 ranges. Designed for use in service shop, or home workshop. Employs thermistor for output regulation. Features high level output, low distortion, and low impedance output. Produces sine waves for audio testing, or will produce good clean square waves with a rise time of only 2 microseconds. Very simple to build from complete instructions supplied.

MODEL AO-1
$24.50
Shpg. Wt. 10 Lbs.

Heathkit AUDIO ANALYZER KIT

Combines AC VTVM, audio wattmeter, and intermodulation distortion analyzer in one instrument. Includes built-in high and low frequency oscillators for IM tests. VTVM ranges are .01, .03, .1, .3, 1, 3, 10, 30, 100, and 300 volts rms. Wattmeter ranges are .15 mw, 1.5 mw, 15 mw, 150 mw, 1.5 w, 15 w, and 150 w. IM scales are 1%, 3%, 10%, 30%, and 100%. Provides internal loads of 4, 8, 16, or 600 ohms. An extremely valuable instrument for the audio engineer, or for the serious audiophile.

MODEL AA-1
$59.50
Shpg. Wt. 13 Lbs.

Heathkit BROADCAST BAND RECEIVER KIT

Build your own radio with confidence, even if you are a beginner. Features transformer power supply, miniature tubes, built-in antenna, 5½" PM speaker, and planetary tuning from 550 kc to 1600 kc. Complete step-by-step instructions supplied.

Cabinet, as shown, available separately.

MODEL BR-2
$17.50
(less cabinet)
Shpg. Wt. 10 Lbs.

Heathkit VISUAL-AURAL SIGNAL TRACER KIT

Features a high-gain RF input channel for signal tracing and troubleshooting from the receiver antenna input clear through all RF and IF stages. Separate low-gain channel for audio circuit exploration. Built-in loudspeaker provides audio response, while electron beam "eye" tube gives visual indication. Ideal for signal tracing in AM, FM, and TV receivers. Built-in wattmeter and noise locating circuit.

MODEL T-3
$23.50
Shpg. Wt. 9 Lbs.

HEATH COMPANY A Subsidiary of Daystrom, Inc. **BENTON HARBOR 20, MICH.**

Heathkit DX-100
PHONE & CW TRANSMITTER KIT

This transmitter is rapidly becoming the accepted standard in its price class. 100 watts RF output—built-in power supplies—built-in VFO and modulator—bandswitching on 160, 80, 40, 20, 15, 11, and 10 meters—phone or CW operation. 100 watts output on phone, and 120 watts on CW. TVI suppressed—pi network output coupling—extensive shielding—matches 50 to 600 ohms—high quality components. Uses 1625 tubes in push-pull to modulate 6146 tubes in parallel. Schematic and specifications available on request.

MODEL DX-100
$189.50
Shpg. Wt. 107 Lbs.

Heathkit DX-35
PHONE & CW TRANSMITTER KIT

This exciting new kit features bandswitching phone and CW operation on 80, 40, 20, 15, 11, and 10 meters. Plate power input to 65 watts on CW, with controlled-carrier modulation peaks to 50 watts on phone. Features built-in modulator, power supplies, pi network output circuit. Panel meter reads grid or plate current for 6146 final. Schematic and specifications on request.

MODEL DX-35
$56.95
Shpg. Wt. 24 Lbs.

Heathkit CW AMATEUR TRANSMITTER KIT

Outstanding dollar-per-watt value! 30-35 watts plate power input, bandswitching for 80, 40, 20, 15, 11, and 10 meters. Crystal or external VFO excitation. 52 ohm ouput—key click filter—copper-plated chassis—pre-wound coils. Uses 6AG7 ocsillator, 6L6 final.

MODEL AT-1
$29.50
Shpg. Wt. 15 Lbs.

Heathkit VFO KIT

Go VFO for added convenience and flexibility. Covers 160-80-40-20-15-11 and 10 meters. Three basic oscillator frequencies provide better than 10 volt average RF output. Plug for crystal socket of transmitter. VR tube for stability. Requires only 250 VDC at 20 ma, and 6.3 VAC at 0.45 A.

MODEL VF-1
$19.50
Shpg. Wt. 7 Lbs.

Heathkit ANTENNA COUPLER KIT

Matches between transmitter and a long-wire, end-fed antenna. Incorporates an L-type filter to attenuate signals above 36 mc and reduce TVI. 52-ohm coaxial input. Tapped inductor and variable capacitor. Neon RF indicator—simple to build. Handles up to 75 watts, 10 through 80 meters. Use with AT-1 or DX-35.

MODEL AC-1
$14.50
Shpg. Wt. 4 Lbs.

Heathkit "Q" MULTIPLIER KIT

Tunes any signal within IF of receiver, with effective Q of approximately 4,000. Sharp "peak" or "null" surpasses crystal filter in operation. Use with 450-460 kc IF. Will not function with AC-DC receivers. Requires 6.3 VAC at 300 ma, and 150-250 VDC at 2 ma. Cable and plugs supplied.

MODEL QF-1
$9.95
Shpg. Wt. 3 Lbs.

Heathkit COMMUNICATIONS TYPE ALL BAND RECEIVER KIT

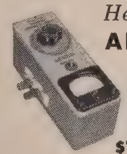
Unusual sensitivity and selectivity for price. Covers 550 kc to 30 mc in 4 bands. AC power supply—electrical bandspread—antenna trimmer—separate RF and AF gain controls—noise limiter—headphone jacks—AGC—BFO. Cabinet available separately as shown. Part 91-15A, shipping weight 5 lbs. $4.50.

MODEL AR-3
$27.95
(Less Cabinet)
Shpg. Wt. 12 Lbs.

Heathkit GRID DIP METER KIT

Use for determining unknown frequency, for checking resonance of tuned circuits, or for adjusting wave traps. Equally valuable in ham shack, service shop, or laboratory. Features 500 ua. meter with sensitivity control. Covers 2 mc to 250 mc with five coils, supplied with kit. Coils pre-wound, dial scale pre-calibrated.

MODEL GD-1B
$19.50
Shpg. Wt. 4 Lbs.

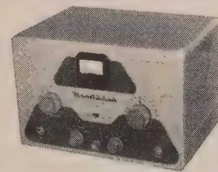


Heathkit ANTENNA IMPEDANCE METER KIT

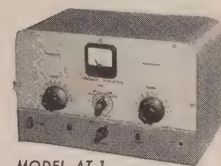
Use this instrument, with a source of RF signal, to determine antenna impedance, line impedance, and to solve impedance matching problems with fixed or mobile antennas or transmission lines. Also, will double as a field strength indicator, or phone monitor. Uses 100 ua. meter. Covers 0 to 600 ohms.

MODEL AM-1
$14.50
Shpg. Wt. 2 Lbs.

MODEL DX-100
PHONE & CW TRANSMITTER KIT

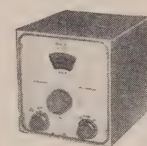


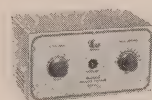
MODEL DX-35
PHONE & CW TRANSMITTER KIT



MODEL AT-1
CW AMATEUR TRANSMITTER KIT

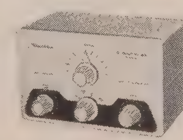
MODEL VF-1
VFO KIT

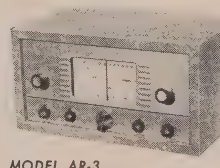




MODEL AC-1
ANTENNA COUPLER KIT

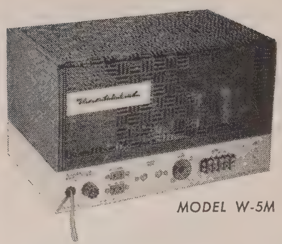
MODEL QF-1
"Q" MULTIPLIER KIT



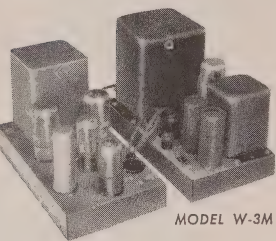


MODEL AR-3
ALL BAND RECEIVER KIT

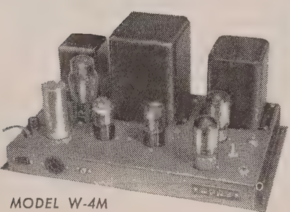
HEATH COMPANY A Subsidiary of Daystrom, Inc. **BENTON HARBOR 20, MICH.**



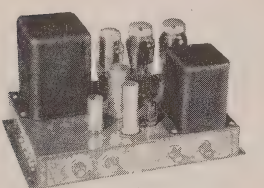
MODEL W-5M



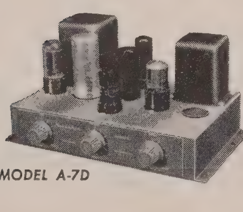
MODEL W-3M



MODEL W-4M



MODEL A-9B



MODEL A-7D

Heathkit ADVANCE-DESIGN HIGH FIDELITY AMPLIFIER KIT

This 25 watt amplifier incorporates the "extra" features required for really outstanding performance, and yet is priced within the range of the average audiophile. Employs KT66 output tubes in push-pull, and features the famous Peerless output transformer. Response is within ±1 db from 5 cps to 160 kc at 1 watt. Harmonic distortion only 1% at 25 watts, 20 to 20,000 cps. IM distortion only 1% at 20 watts. Output impedance is 4, 8, or 16 ohms. Hum and noise are 99 db below rated output. Features "tweeter saver," and unique balancing circuit. Handles power peaks up to 42 watts.

KIT COMBINATIONS:

W-5M Amplifier Kit: Consists of main amplifier and power supply, all on one chassis. Complete with all necessary parts, tubes, and comprehensive manual.

Express only **$59.75** *Shpg. Wt. 31 Lbs.*

W-5 Combination Amplifier Kit: Consists of W-5M Amplifier Kit listed above *plus* Heathkit Model WA-P2 Preamplifier Kit. Complete with all necessary parts, tubes, and construction manuals.

Express only—Shipping weight 38 lbs.............................$79.50

Heathkit DUAL-CHASSIS HIGH FIDELITY AMPLIFIER KIT

The Model W-3M features the famous Acrosound TO-300 "ultra linear" output transformer. It uses 5881 tubes and has a frequency response within ±1 db from 6 cps to 150 kc at 1 watt. Harmonic distortion only 1% at 21 watts. IM distortion at 20 watts only 1.3% at 60 and 3,000 cps. Power output is 20 watts. Output impedance is 4, 8, or 16 ohms. Hum and noise is 88 db below 20 watts. A very popular high fidelity unit. Main amplifier and power supply on separate chassis.

KIT COMBINATIONS:

W-3M: Consists of main amplifier and power supply for separate chassis construction. Includes all tubes and components necessary for assembly.

Express only **$49.75** *Shpg. Wt. 29 Lbs.*

W-3: Consists of W-3M Kit listed above *plus* Heathkit Model WA-P2 Preamplifier described on opposite page.

Express only—Shipping weight 37 lbs.............................$69.50

Heathkit SINGLE-CHASSIS HIGH FIDELITY AMPLIFIER KIT

Model W-4A is the original low-priced Williamson Amplifier Kit. A Chicago output transformer and 5881 output tubes are featured. Frequency response is ±1 db from 10 cps to 100 kc at 1 watt. Harmonic distortion only 1.5% at 20 watts. IM distortion only 2.7%. 20 watts output at 4, 8, or 16 ohms. Hum and noise 95 db below 20 watts. A tried and proven unit featuring a "polished" circuit that may be depended on for reliable high fidelity performance.

KIT COMBINATIONS:

W-4AM: Consists of main amplifier and power supply for single chassis construction. Includes all tubes and components necessary for assembly.

Express only **$39.75** *Shpg. Wt. 28 Lbs.*

W-4A: Consists of W-4AM Kit listed above *plus* Heathkit Model WA-P2 Preamplifier described on opposite page.

Express only—Shipping weight 35 lbs.............................$59.50

Heathkit 20-WATT HIGH FIDELITY AMPLIFIER KIT

This amplifier can provide you with high fidelity at a surprisingly low price. Preamplifier built into same chassis as main amplifier. Four switch selected, compensated inputs are available, as are bass and treble tone controls, providing necessary flexibility for home or public address installations at a minimum investment. Features full 20-watt output using push-pull 6L6 tubes. Employs miniature tube types in preamp for low hum and noise. Frequency response is ±1 db from 20 to 20,000 cps. Harmonic distortion only 1% at full output. Shop and compare —a real "best buy" for you.

MODEL A-9B **$35.50** *Shpg. Wt. 23 Lbs.*

Heathkit 7-WATT AMPLIFIER KIT

The 7-watt output of this amazing little amplifier is more than adequate for normal home installations. Using a tapped-screen output transformer of new design, its frequency response is ±1½ db from 20 to 20,000 cps. It provides good sensitivity, with surprisingly low distortion. Transformer tapped at 4, 8, and 16 ohms. Push-pull output. Separate bass and treble tone controls are provided.

MODEL A-7D **$16.95** *Shpg. Wt. 10 Lbs.*

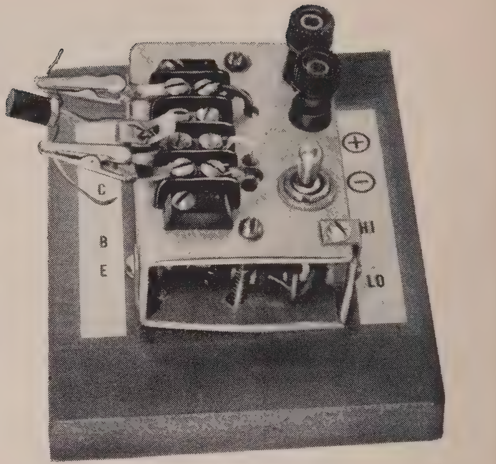
MODEL A-7E: Same as Model A-7D, but with stage of preamplification. Extra gain for low level cartridges. RIAA compensation.

Shipping weight 10 lbs..........................$18.50

SPECIAL NOTE: Don't overlook the possibilities of a hi-fi system consisting of the FM-3, the Model A-7E, and the Model SS-1 Speaker System. For only $82.95, you can have high fidelity in your home.

HEATH COMPANY A Subsidiary of Daystrom, Inc. **BENTON HARBOR 20, MICH.**

MULTIMETER TRANSISTOR CHECKER



The transistor test unit.

Uses ohmmeter range of meter to test operation as triode

By SOL D. PRENSKY

AT a time when the use of transistors in radios and other commercial equipment is increasing by leaps and bounds, the means for checking them are lagging behind. These little devices deserve a better fate than the resistance check currently used. The method presented here allows a practical check to be made rapidly by using a combination of your multimeter with a very simple external test unit.

The conventional ohmmeter check measures the forward and back resistances between two of the transistor elements taken at a time, as if it were a double diode with a common base. Although this method reveals an open, short or other extreme kind of transistor failure, it furnishes no evidence that the transistor may be unsatisfactory when operating as a triode. For example, in testing whether a transistor had been damaged by soldering heat, the conventional diode-check method might easily pass the transistor because it may show a much higher back than forward resistance. Actually, it can be very poor in triode performance. Thus, it is important to be able to get some indication of triode action, if only a rough one. This test unit provides just such an indication. It registers a substantial change in meter reading, indicating a large change in output collector current resulting from a small change applied to the input base circuit of the transistor under test. In short, even though it is a simple check, it adds the highly desirable feature of checking the transistor as a triode.

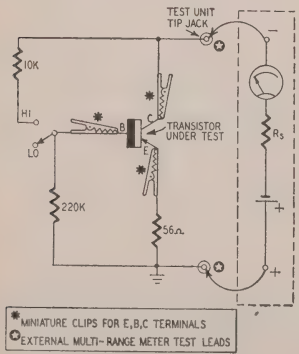


Fig. 1—Setup for transistor check.

Aside from the newness of the transistor art the main obstacle to a simple and straightforward test is the fact that the transistor is highly sensitive to the choice of its dc operating point. Even if we ignore the various other factors that transistor operation depends upon—temperature, impedance matching and the like—widely different results for current amplification are likely to be obtained for slightly different operating points. For a power transistor, for example, the operating point may be very different than for a general-purpose unit.

Despite these difficulties, it is still feasible to cut through many test qualifications by keeping firmly in mind that our object is to check a transistor's condition, and not make a comprehensive test of transistor characteristics. For our purposes, we can concentrate on the following two questions:

Is the test safe and simple enough to be practical?

Do the results reveal a defective transistor?

As to being practical, the test unit requires only a few fixed resistors, a toggle switch and a terminal strip for mounting. When used with the proper multimeter scale, both meter and transistor are protected from damage by the current-limiting provisions built into the multirange meter. Used under these conditions, the largest voltage that can be applied to the transistor is 1.5 (or, for some meters, up to 4.5 volts) and there is no necessity for switching ranges. The entire operation is no more complicated than taking two ohmmeter readings.

As to its ability to detect a faulty transistor, the test unit not only detects the more obvious resistance defects that would show up in a diode resistance check but also reveals faulty triode action by indicating relative current changes resulting from the amplifying ability of the transistor. Keep in mind that these readings are not intended for comparing the merits of different makes or configurations of transistors, but rather as a practical means of comparing the action of a questionable transistor with that of a good one of the same type.

Transistor check circuit

The test unit (Fig. 1) operates with the transistor in a grounded-emitter hookup. This circuitry provides one of the most significant clues to the condition of a transistor—its ability to amplify small changes in its base current. To do this, the test takes advantage of the circuitry in conventional service type multimeters on their resistance ranges (shown in dashed lines). This section already contains a 1.5-volt cell for voltage supply, a sensitive meter and a series limiting resistor R_s which protects both the meter and the transistor under test. Using these, the test circuit boils down to providing a means for indicating

changes in current as the transistor is checked.

The first meter reading is taken with the spdt toggle switch in its LO position, corresponding to zero base current bias. The toggle switch is then thrown to HI. This sends a small dc bias current through the base of the transistor, causing a much larger current to flow in the collector circuit. The increase in meter reading indicates the relative current-amplifying ability of the transistor under dc conditions. The difference between the high and low reading is then compared with the meter-swing increase caused by a good transistor of the same type. This provides a check on the condition of the transistor.

No attempt is made to measure ac signal performance since this is more properly a manufacturing measurement. It is more the point for a transistor check to detect those signs that point to possible deterioration or failure. Passing over the more obvious defects—opens or shorts—that show up immediately, there remain two major indications of possible deterioration: (1) a marked increase in the relative I_c, the amount of collector current that flows at zero base current, indicated by the meter reading in the LO position; (2) a substantial decline in the transistor's current-amplifying ability, the difference between the HI and LO meter readings.

Transistor-check procedures

Since the transistor, like other semiconductors, is a nonlinear device, its effective resistance may vary widely, depending on the voltage across it. Thus, different ohmmeters, or more important, different ranges of the same ohmmeter, will result in noncomparable readings. This need not present any serious difficulties as long as only one ohmmeter and one resistance range of that meter is used, but it is well to understand the limitations. The meter used here is a Precision model 120. On its X100 resistance range it uses a 1.5-volt cell and has a center scale of 2,000 ohms. Any ohmmeter, using not more than 4.5 volts and having a center-scale reading of between 1,000 and 3,000 ohms is also suitable, with the proper allowance made for expected readings as compared with those of a good transistor.

The polarities shown in the circuit diagram are for p-n-p transistors. *The positive polarity does not necessarily coincide with the red lead of any particular ohmmeter.* In the Precision 120, as in many others, the red lead is connected to the negative terminal of the ohmmeter battery. It is a simple matter to check this polarity on a voltmeter. It can even be checked on a diode, known to be good, by observing which polarity gives the conventional easy current flow for forward resistance.

For the p-n-p transistor check, a

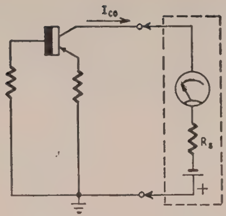


Fig. 2—Check circuit in LO position.

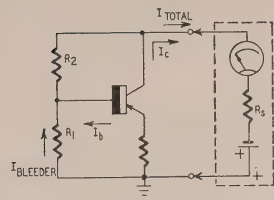


Fig. 3—Check circuit in HI position.

negative polarity is applied to the collector. With the switch at LO there is zero base current and the meter indicates the so-called saturation current (I_c) flowing in the collector circuit (Fig. 2). When the switch is thrown to HI (Fig 3), the base is connected to a sufficiently negative point on the voltage divider (R1 and R2) so that a small bias current (about 50 μa) flows through the base circuit. This results in a greatly increased collector current for the second reading. The difference in the two readings indicates the approximate relative effectiveness of the transistor for current amplification.

Strictly speaking, the second reading is made up of more than just the collector current; it is the sum of the collector current and the currents flowing in the base and the voltage-divider circuits. The situation does not introduce any serious inaccuracies, since, in the case of a typical transistor, the amounts of base current (around 50 μa) and bleeder current (around 6 μa) together form only a small part of the total reading (around 500 μa). Thus, the HI reading is made up of collector current for the most part (around 90%) and, therefore, a large difference between the HI and LO readings gives a sufficiently valid indication of the current-amplifying ability of a transistor. The emitter resistor provides stabilization for the dc operating point used.

There is an incidental benefit derived from using the ohmmeter connection as shown. If an n-p-n transistor is to be tested, reverse the ohmmeter leads. The simple flipover automatically insures that the bias and collector circuits are connected to their proper polarities for the n-p-n transistor. The meter will still read in the forward direction and readings will be equally valid for this type of transistor.

The table gives a summary of results obtained with good transistors (and two defective ones, as noted), using the test unit connected to a Precision 120 meter. In all, more than 30 transistors were tried, divided by types into three groups.

After the first column of the table,
(*Continued on page* 72)

SUMMARY OF CHECK RESULTS

Average meter readings—good transistors

Transistor Group	Lo (Based on scale of 60)	Hi (Based on scale of 60)	Net Change Hi–Lo
General Purpose	6	40	34 24–40*
Rf	3	38	35 34–37*
Af	5	43	38 37–39*

Average meter readings—bad transistors

General Purpose	Lo	Hi	Net Change
Sample 1†	6	18	12
Sample 2††	1	7	6

* Range of individual net change in this group.

† Had been exposed to excessive soldering heat. Still showed satisfactory back-to-forward resistance.

†† Excessively high resistance in both forward and reverse directions.

NOTE: For a workable minimum, a transistor should give a net change of at least 50% of the net-change figure to be considered good.

Transistors Used in Above Checks (p-n-p unless otherwise noted)

General Purpose	Rf	Af
Amperex 0C71	HydroAire HF1	Amperex 0C72
Germanium Products (n-p-n) 2N103, 2N99	Raytheon CK760	G-E 2N44
HydroAire CQ1	Texas Instruments (n-p-n) 223-536	Transitron 2N44, 2N85
Raytheon CK722		
Transitron 2N34, 2N35, 2N65		

New! SICO *Streamlined* TUBE TESTERS

Superior's New Model TC-55

FOR
- **The Experimenter or Part-time Serviceman,** who has delayed purchasing a higher priced Tube Tester.
- **The Professional Serviceman,** who needs an extra Tube Tester for outside calls.
- **The busy TV Service Organization,** which needs extra Tube Testers for its field men.

• **You can't insert a tube in wrong socket.** Separate sockets are used, one for each type of tube base. • **"Free-point" element switching system** Any pin may be used as a filament pin and the voltage applied between that pin and any other pin, or even the "top-cap". • **Checks for shorts and leakages between all elements.** Provides a super sensitive method of checking for shorts and leakages up to 5 Megohms between any and all of the terminals. Continuity between various sections is individually indicated. • **Elemental switches are numbered in strict accordance with R.M.A. specification.** The 4 position fast-action snap switches are all numbered in exact accordance with the standard R.M.A. numbering system.

Speedy, yet efficient operation is accomplished by: Elimination of old style sockets used for testing obsolete tubes (26, 27, 57, 59, etc.) and providing sockets and circuits for efficiently testing the new Noval and Sub-Minar types.

Model TC-55 comes complete with operating instructions and charts and streamlined carrying case.

$26.95 NET

SICO PICTURE TUBE TESTER

Superior's New Model TV-40

• **Tests all magnetically deflected tubes . . . in the set . . . out of the set . . . in the carton!!**

• **A complete picture tube tester for little more than the price of a "make-shift" adapter!!**

The Model TV-40 is absolutely complete! Self-contained, including built-in power supply, it tests picture tubes in the only practical way to efficiently test such tubes; that is by the use of a separate instrument which is designed exclusively to test the ever increasing number of picture tubes!

SPECIFICATIONS

Tests all magnetically deflected picture tubes from 7 inch to 30 inch types. • Tests for quality by the well established emission method. All readings on "Good-Bad" scale. • Tests for inter-element shorts and leakages up to 5 megohms. • Test for open elements.

Model TV-40 comes absolutely complete — nothing else to buy. Housed in round cornered, molded bakelite case. Only . . .

$15.85 NET

SICO

Superior's New Model TY-11
Standard Professional

TUBE TESTER

★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TV-II as any of the pins may be placed in the neutral position when necessary.

★ The Model TV-II does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.

★ Free-moving built-in roll chart provides complete data for all tubes.

★ NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRA SERVICE — The Model TV-II may be used as an extremely sensitive Condenser Leakage Checker. A relaxation type oscillator incorporated in this model will detect leakages even when the frequency is one per minute.

The model TV-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover.

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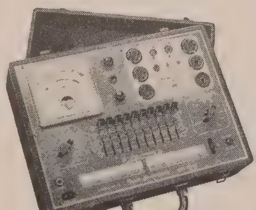
SICO TRANS-CONDUCTANCE TUBE TESTER

Superior's New Model TV-12



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A transistor can be safely and adequately tested only under dynamic conditions. The Model TV-12 will test all transistors in that approved manner, and quality is read directly on a special "transistor only" meter scale.

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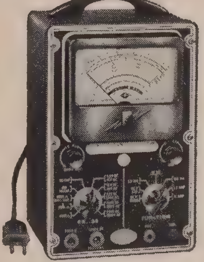
Superior's New Model 670-A SUPER-METER



SPECIFICATIONS

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500/7,500 Volts
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
OUTPUT VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes
RESISTANCE: 0 to 1,000/100,000 Ohms 0 to 10 Megohms
CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd. (Good-Bad scale for checking quality of electrolytic condensers.)
REACTANCE: 50 to 2,500 Ohms 2,500 Ohms to 2.5 Megohms
INDUCTANCE: .15 to 7 Henries 7 to 7,000 Henries
DECIBELS: −6 to +18 +14 to +38 +34 to +58

ADDED FEATURE:
Built-in ISOLATION TRANSFORMER reduces possibility of burning out meter through misuse.

The Model 670-A comes housed, in a rugged crackle-finished steel cabinet complete with test leads and operating instructions.

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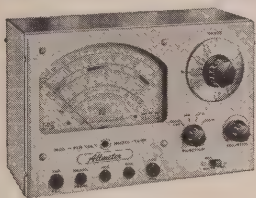
SICO Superior's New Model TV-60

20,000 OHMS PER VOLT ALLMETER



Includes services never before provided by an instrument of this type. Read and compare features and specifications below!

FEATURES

- Giant recessed 6½ inch 40 Microampere meter with *mirrored scale.*
- Built-in Isolation Transformer.
- Use of the latest type *printed circuit* and 1% multipliers assure unchanging accurate readings.

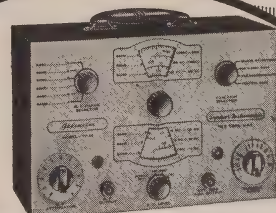
SPECIFICATIONS

8 D.C. VOLTAGE RANGES: (At a sensitivity of 20,000 Ohms per Volt) 0 to 15/75/150/300/750/1500/7500/30,000 Volts.
7 A.C. VOLTAGE RANGES: (At a sensitivity of 5,000 Ohms per Volt) 0 to 15/75/150/300/750/1500/7500 Volts.
3 RESISTANCE RANGES: 0 to 2,000/200,000 Ohms, 0-20 Megohms
2 CAPACITY RANGES: .00025 Mfd. to 30 Mfd.
5 D.C. CURRENT RANGES: 0-75 Microamperes, 0 to 7.5/75/750 Milliamperes, 0 to 15 Amperes.
3 DECIBEL RANGES: −6 db to +58 db
RF SIGNAL TRACER SERVICE: Enables following the R.F. signal from the antenna to speaker of any radio or TV receiver and using that signal as a basis of measurement to first isolate the faulty stage and finally the component or circuit condition causing the trouble.
AUDIO SIGNAL TRACER SERVICE: Functions in the same manner as the R.F. Signal Tracing service specified above except that it is used for the location of cause of trouble in all audio and amplifier systems.

Model TV-60 comes complete with book of instructions; pair of standard test leads; high-voltage probe; detachable line cord; R.F. Signal Tracer Probe and Audio Signal Tracer Probe. Pliofilm bag for all above accessories is also included. Price complete. Nothing else to buy. ONLY

$52.50

SICO



Superior's New Model TV-50

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A versatile all-inclusive GENERATOR which provides ALL the outputs for servicing:

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R. F. SIGNAL GENERATOR: Provides complete coverage for A.M. and F.M. alignment. Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics. • **VARIABLE AUDIO FREQUENCY GENERATOR:** In addition to a fixed 400 cycle sine-wave audio, the Genometer provides a variable 300 cycle to 20,000 cycle peaked wave audio signal. • **BAR GENERATOR:** Projects an actual Bar Pattern on any TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars. • **CROSS HATCH GENERATOR:** Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting horizontal and vertical lines interlaced to provide a stable cross-hatch effect. • **DOT PATTERN GENERATOR (FOR COLOR TV):** The Dot Pattern projected on any color TV Receiver tube by the Model TV-50 will enable you to adjust for proper color convergence. • **MARKER GENERATOR:** The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc., (3579 Kc. is the color burst frequency.)

MODEL TV-50 comes absolutely complete with shielded leads and operating instructions. Only

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- ☐ Model TV-11..............Total Price $47.50 $11.50 within 10 days. Balance $6.00 monthly for 6 months.
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identifying the transistor group, typical meter readings are given in the next two columns for the LO and HI positions of the test switch. The difference between these two gives the *net change*, a measure of *relative sensitivity*.

If some other meter is used, the results of the table can easily be adapted, provided the meter's X100 resistance scale is reasonably sensitive. The internal battery of the meter on this range should be between 1.5 and 4.5 volts and the center scale for the same range should read between 1,000 and 3,000 ohms.

The following example relates the table's meter readings to another meter having a center scale of 1,000 ohms and a 3-volt internal battery on its X100 resistance range: The full-scale sensitivity of such a meter on this range can be calculated to be 3 volts divided by the center-scale reading of 1,000 ohms, giving a full-scale deflection (with the test leads shorted) of 3,000 μa or 3 ma. This compares with 1.5 volts divided by 2,000 ohms or 750 μa for the Precision 120 used in the table. Thus, the substitute meter has a sensitivity of only one-fourth that of the meter used and it can therefore be expected that the readings obtained for the average transistor will be approximately one-fourth that of the readings shown in the table.

The more sensitive meter will discriminate more between good and bad transistors, but there is sufficient latitude in the check method to spot a poor transistor even with the less sensitive one. As a corollary, if the constructor wishes to build an independent transistor checker with a battery and milliammeter, he will be well advised to use a meter having 1-ma full-scale deflection, for convenience in calculations.

Before checking a transistor as a triode, check each B to E and B to C diode of the transistor for forward and back resistance. This eliminates transistors having obvious defects involving short, open or erratic (intermittent) readings.

Parts for transistor checker

1—56, 1—10,000, 1—220,000 ohms, ½-watt resistors; 1—terminal strip, double-screw type, three terminals; 3—alligator clips (solder to soldering lug for mounting on terminal strip), midget type; 1—chassis; 1—spdt switch; 2—tip jacks.

Because of the rugged construction and the long operating life of transistors in general, be cautious about blaming the transistor for poor circuit operation. This is a vastly different approach from the method we have been accustomed to in tube circuits, where the tube turns out to be the culprit perhaps 90% of the time. In normal use, a transistor does not damage or deteriorate easily although it does not take much to damage a transistor through excessive voltages or excessive heat. Even polarity reversals need not harm the transistor as long as the maximum voltage and current rating are not exceeded. END

ITV pulse-generator techniques

Kay Lab closed-circuit TV monitor.

Industrial television; closed-circuit systems: Part I— Synchronization, scanning and pulse formation

By EDWARD M. NOLL*

THE pulse or sync generator is the timing heart of a television system. In commercial telecasting the sync generator is a complex piece of electronic gear. The pulse generator of an industrial television camera, with its less exacting requirements, is a simplified version of the telecasting sync generator.

The pulse generator forms the synchronizing and blanking pulses used to trigger the horizontal and vertical deflection generators of both camera tube and picture tube. In any television system (Fig. 1), the synchronous motion of two scanning beams, camera tube and picture tube, locks in line by line in the pickup and reproduction of a scene.

The television station sends out horizontal and vertical sync pulses which control the horizontal and vertical motion of the scanning beam of the receiving picture tube. Horizontal and vertical pulses, in like manner, control the scanning activity of the picture tube of an industrial television viewer. In fact, a standard television receiver is often used as a closed-circuit television viewer. In addition to these viewer pulses a pair of similarly timed pulses control the motion of the camera-tube scanning beam. At the camera tube, the scanning beam gathers the video signal line by line off an image of the scene to be transmitted. At the viewer picture tube, a scanning beam moves in step to reproduce the image in the same orderly sequence it was released.

Blanking pulses are sent between television station and the home television receiver so that the receiver screen is blanked out during the horizontal and vertical retrace intervals. Blanking pulses are also supplied to the camera tube to prevent it from releasing video information during the retrace intervals of the camera-tube scanning motion. Thus sync and blanking pulses perform similar functions in the operation of camera pickup tubes and conventional TV receiver picture tubes.

Sync generation for ITV

The horizontal and vertical scanning rates of an industrial system are often, but need not be, the same as the commercial standards of 15,750 cycles line rate and 60 cycles field rate. The advantage of using the same scanning rates is that any conventional television receiver can then be used as an industrial television viewer. However, nonstandard rates and equipment are not uncommon and are sometimes used for specialized functions.

A sync generator for closed-circuit operation can be as simple as that shown in Fig. 2. Two pulse-forming generators are required—one operating at a line rate of 15,750 pps and a second at a field rate of 60 pps. The horizontal and vertical pulses generated are sent to camera-tube as well as picture-tube sweep circuits. Pulses can be sent on separate lines to viewer deflection circuits or they can be combined with the video and then separated at the viewer.

In this simple arrangement the same generated pulse acts as both sync pulse and blanking pulse. The leading edge of the pulse is used for synchronization; the duration of the pulse is long enough for blanking.

A more elaborate generator (Fig. 3)

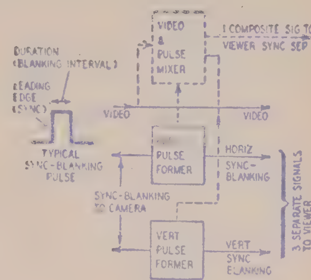


Fig. 2—Simple ITV sync generator.

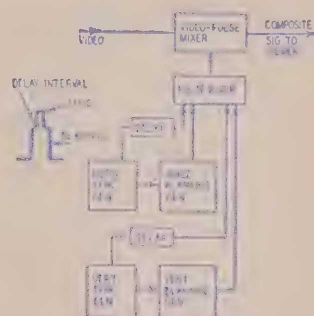


Fig. 3—Diagram of system using separate horizontal and vertical blanking.

would include separate blanking generators. Even a delay circuit can be included so that the sync pulse doesn't rise until a specified interval after the start of the blanking. This type of combined sync and blanking pulse compares with standard commercial telecast pulse construction. It is important to recognize how few signal components are needed to convey a closed-circuit picture as compared to the complex standard composite telecast signal.

Sequential and interlace scanning

The pulse generator systems shown in Figs. 2 and 3 form a sequential scanning pattern with the raster being formed line after line in sequential order down the screen (Fig. 4). To form an interlace pattern the horizontal frequency must be related exactly to the vertical frequency—a half-line relationship so that the lines of the second field fall between those of the

* Author, *Closed-Circuit and Industrial Television* (Macmillan).

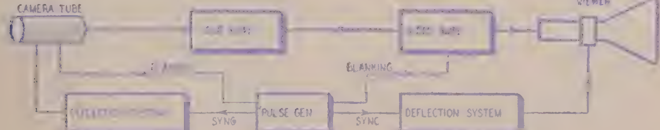
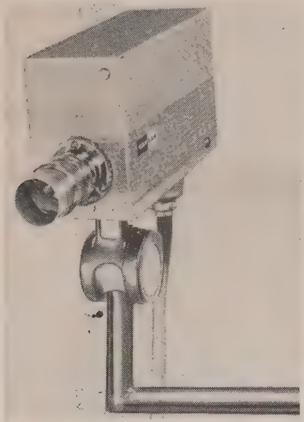


Fig. 1—Block diagram shows components of a basic television system.



Kay Lab closed-circuit TV camera.

first. In commercial telecast practice the half-line relationship is the quotient of the line rate divided by field rate:

$$\text{lines per field} = \frac{\text{line rate}}{\text{field rate}} = \frac{15{,}750}{60} = 262\tfrac{1}{2}$$

This rigid relationship between line and field rates is obtained with a counter chain (Fig. 5). A counter chain is a frequency divider, as compared to the more familiar frequency doubler. The output of a counter is a submultiple of the exciting frequency. In other words a 525-to-1 counter, if excited with an input signal having a frequency of 31,500 cycles, has an output frequency of 31,500/525 or 60 cycles. This method of dividing is used in commercial telecast practice as well as interlace industrial television systems. The 31,500-cycle signal is also divided by a 2-to-1 counter to obtain the standard line rate of 31,500/2 or 15,750 cycles.

Since the advent of color, the line and field rates have been modified slightly to 15,734.26 and 59.94, respectively. Still the quotient of the two rates remains at a fixed value of 262½ to establish proper interlace.

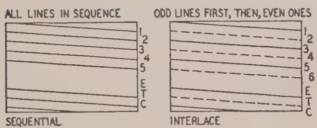


Fig. 4—Two common scanning systems.

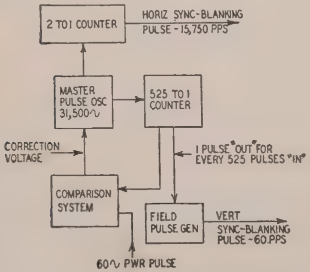


Fig. 5—An interlace pulse generator.

In industrial TV gear the field rate is locked at the power-line frequency. A power-locked system is less susceptible to hum disturbances. To maintain a constant count and, at same time, lock in at the power frequency, a phase-comparison circuit is required. Its function is to compare the field output of the counter with the power-line frequency, developing a correction voltage that is supplied to the double line rate or master oscillator. Thus the line-rate frequency is held to a rate that is always the proper half-line multiple of the field rate while the field rate is fixed to the power frequency.

Thus the major component circuits of a pulse generator are: pulse-forming generators and shapers, pulse counters, comparison systems.

Pulse formation

The two basic pulse-forming generators are the blocking-tube oscillator and the multivibrator, commonly used in the formation of deflection sawtooth waves for oscilloscope and television picture tubes.

A typical blocking-tube pulse generator is shown in Fig. 6. It does not differ too much from the familiar sawtooth-forming blocking-tube oscillator. Instead of a sawtooth voltage being formed at the plate, a pulse is formed at the cathode.

The grid waveform, as shown, is approximately the same as that of a sawtooth-forming blocking-tube circuit where the grid time constant determines the oscillator frequency. Once capacitor C is charged to a high negative voltage the tube remains cut off until C discharges sufficiently through resistor R to reach tube conduction bias. When tube current flow begins, the feedback via the blocking-tube transformer drives the grid in the positive direction rapidly. This rise continues until feedback is no longer able to support any further grid voltage rise. Grid current flow acts as a limiting factor on grid voltage increase beyond a certain limit. Now the cycle reverses and feedback is in a direction that drives the grid far beyond cutoff by charging C to a high negative voltage. Hence a new cycle begins with the discharge of capacitor C.

So far as pulse generation is concerned, the time of tube conduction is important. During this interval the flow of tube current through the cathode resistor generates a positive short-duration pulse across the cathode resistor that continues for the interval the tube conducts. However, the sync and blanking pulses are of short duration with a much longer interval between pulses. Generally the pulse is only some 5–15% of the pulse period. Thus, the blocking tube is ideal for a pulse generator, forming a pulse of short duration in comparison to the spacing between pulses.

The multivibrator too can be used as a pulse-forming circuit. It it asymmetrical—one of the tubes conducts for a much longer period of time than the second (Fig. 7). The tube with the long-time-constant grid circuit conducts for a much shorter period of time than its partner.

Tube V2 conducts for a long interval because of its short-time-constant grid circuit. It is *on* for a long period of time and *off* for a short period. The pulse at the cathode of the tube with the long time constant (V1) is positive during its short conducting interval. A long positive pulse develops at the cathode of V2 because it has such a long conducting time. However, if we look at this pulse as a negative one it is really a short negative pulse. Hence the multivibrator forms time-coincident positive and negative pulses.

Just as in television receiver practice, the horizontal and vertical rate signals can be generated by blocking-tube oscillator or multivibrator. Of course, to generate the horizontal pulses the frequency-controlling time constants must be shorter than in the formation of low-frequency vertical pulses. TO BE CONTINUED

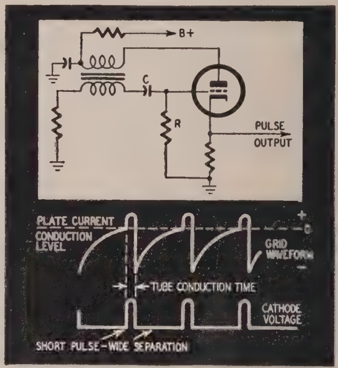


Fig. 6—Blocking-tube pulse generator.

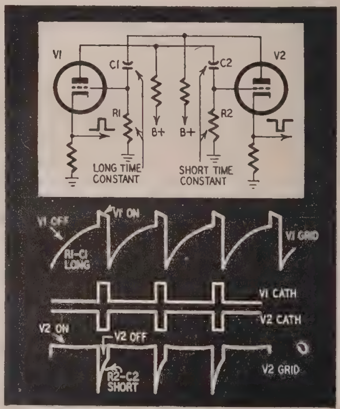


Fig. 7—Multivibrator and waveforms.

TV DX

RADIO-ELECTRONICS is happy to announce that TV DX is again a regular section with Mr. Robert Cooper of Fresno, Calif., as editor. It will appear every alternate issue. This month—a review of 1956, and some hints on the future.

By ROBERT B. COOPER

JANUARY provided dx-ers in western United States with several good sporadic-E openings (hereafter abbreviated E's) during the third week, with conditions peaking from the 18th to 20th. Richard Lowry of Temple, Tex., reports reception of XEQ, channel 9, Mexico City, on Jan. 19, at 5 p.m. CST. This distance of 900 miles is quite unusual in that any loggings via sporadic-E skip above channel 6 seldom occur.

The evening of Jan. 23 brought excellent sporadic-E conditions from the mid-Gulf area to the northeastern states, lasting into the early morning of the 24th.

February reports list only the 12th and 13th active for western and southern areas. March was somewhat better and E's were noted along the Gulf states on March 11, 16 and 20.

April as usual brought the first indication of our summer skip season. April 15 saw one of the largest, most pronounced openings ever observed for April. An example of the unusual scope is the report by Hamilton of Hannibal, Mo., who logged WCBS, WRCV, WBZ, WCR, WCAX, WSYR, WIRI, WMAR, WFIL, CFCM, WABD, WRCA, WRGB and WTWO between 9:27 a.m. and 4:59 p.m. The frequency of E's after the 15th increased with E's noted on April 20, 21, 23, 24, 25, 28 and 30.

May was slow to begin for E's over most of the country, with only scattered openings previous to May 12, when an excellent skip opened for areas west of the Mississippi, from 3 p.m. EST to midnight. All E's seemed to vanish between May 21 and 30. May ended in a better light, however, with a double-hop sporadic-E opening (1,500 miles and farther) from central and southern California to Ohio, West Virginia and Pennsylvania after 11 p.m. EST on the 30th. The morning of May 31 brought more double-hop E's, with WUSN (2, Charleston, S.C.) and WSB (2, Atlanta, Ga.) reported from several locations in California.

An increasing number of observers have begun to report "short bursts" of reception much like regular E's, with the exception that duration is but a few seconds. The majority of these bursts are from stations normally

seen via E's (400–1,500 miles distant). This reception is a direct result of small dust particles entering our E-layer at such a high speed that the friction between dust and air molecules causes the dust particles to burn up, leaving a trail of ionized gas. This trail has the same properties as a regular E-layer skip cloud and therefore reflects the signal to earth at some distant point. The short duration is because the cause of the ionized trail soon dissipates. The interesting part about meteor-scatter reception is that it is possible every day, almost any time of day!

A special RADIO-ELECTRONICS form has been prepared for the use of all long-distance TV fans reporting to this column. These forms will be distributed free of charge and may be obtained by sending a postcard to Robert B. Cooper, RADIO-ELECTRONICS, 154 W. 14th St., New York 14, N. Y. These forms must be used for regular reporting as our compilation of the data you send in is done in a systematic manner based on these forms.

Richard Lowry of Temple, Tex., reports several nice loggings on the evening of April 13, 1956, when WJMR (21, New Orleans) at 435 miles and WAFB (28, Baton Rouge, La.) at 400 were logged with excellent signals.

Another long uhf haul of outstanding merit is reported by Robert Weems, of State College, Miss. Bob found the same interval (April 13–14) good for high-band vhf, so he decided to check the uhf. The result—a new uhf record, with the logging of WGBS-TV, channel 23, Miami, Fla., a distance of 750 miles!

Pvt. Gordon E. Simkin, situated on Bikini Atoll, Pacific Ocean, reports that F2 (long-haul) skip activity is being noted on a regular basis, with reception from Hawaii and the Philippines a nightly feature. The distances are 2,600 miles to the Hawaiian group, 3,000 to Manila.

Long-term predictions for TV dx conditions during August and September have it that E's will drop off very sharply about the time you read this, with only scattered late-afternoon openings after Aug. 15. Tropospheric conditions will continue to improve, reaching a 2- or 3-day peak sometime during the first three weeks of September. This peak will be preceded by a large slow-moving high frontal area of high barometric pressure.

Long-haul F2 skip will probably only go as high as channel 2 this fall, but observers should not neglect the other low-band channels. Watch for F2 dx reception from Central and South American countries in the morning hours (7 a.m. to noon LST) following any night of heavy aurora activity in the northern sky.

Meteor-scatter dx-ers should watch for the annual peak of meteorite showering during the second and third weeks of August. The frequency of MS bursts may increase tenfold. END

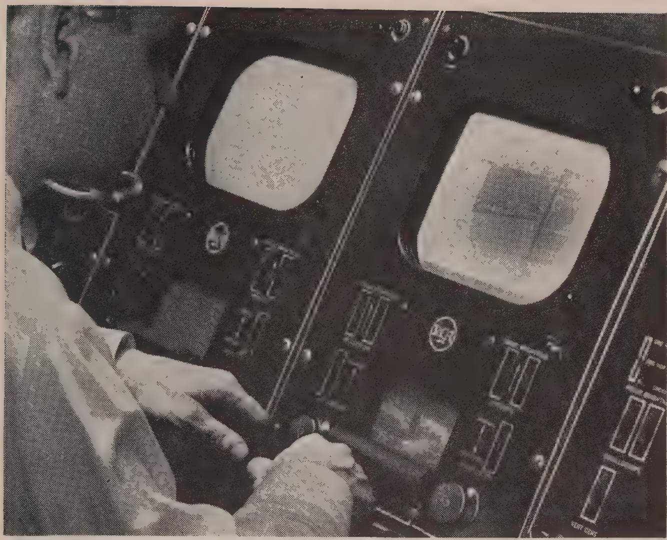


Image orthicon camera control–operator adjusts setup and level on knobs P and G. Camera controls are on sloping panel.

TV SIGNAL TROUBLES *before the receiver*

By A. G. SWAN

TV transmitter troubles can produce misleading receiver symptoms

TV STATIONS usually but not always transmit consistently correct signals. Sometimes the signal departs from the ideal and, when this happens, the effect is likely to show up on receiver screens. Of course, some troubles are due to equipment failures, but others are due to misadjustment of equipment. Often this occurs outside the station. Network programs pass through innumerable amplifiers. Many technicians control them before the signal is aired. Sometimes troubles are additive and sometimes equipment cannot be serviced without interrupting the program.

Many viewers will watch any kind of program material without complaining, but the slightest technical trouble showing up on receiver screens will guarantee at least a few phone calls to the station. Most viewers are annoyed by changes in contrast. This is likely to occur when the station switches from a studio camera to a film camera or from a local to a network program or sometimes even between studio cameras. It is often due to changes in video levels. The change may start in the originating control room and grow progressively worse right through the transmitter.

This trouble is often traced to misreading the scopes. First the camera control operator sets the video level at the output of each camera. Then the control-room technician sets it for feed to a line. If it's a network feed, the telephone company may set it many times. The receiving station sets it at its control room, then the telephone company again. In addition, the transmitter has several shots at it. Now if everyone saw the same thing on his scope, the video level might remain consistent. Unfortunately this is not so.

For example, suppose a program is using two cameras. Camera 1 is behaving normally (Fig. 1-a). Camera 2 is peaked up around 6 mc and shows overshoot (Fig. 1-b). Each of these signals is seen in the control room on its camera-control scope. The operator sets the video gain on each camera control to read 0.7 volt on its scope. Both cameras are looking at the same scene. The director switches camera 1 on the air. The viewer adjusts his receiver. Then the director switches from 1 to 2. Immediately the viewer's screen changes contrast; he is receiving less signal at his kinescope because he is not receiving the 6-mc overshoot. Now if the control operator suddenly limited the response of his scope to say 3 mc, the overshoot on camera 2 would disappear from its scope, the level would read less than 0.7 volt and he would increase it (Fig. 1-c). Now the viewer's receiver would behave more normally.

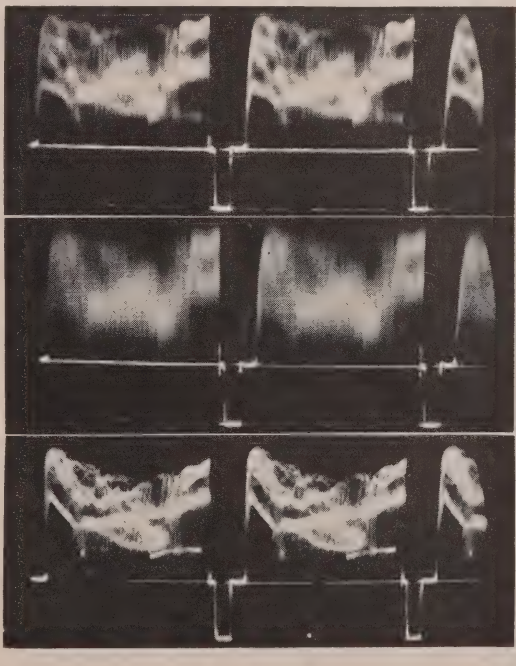


Fig. 1—*a*, Camera output on a wide-band scope; *b*, output contains high-frequency overshoot; *c*, same as *b* but with scope bandwidth limited.

This condition can exist in any number of cases—not just between cameras, but between programs, lines, studios. It also causes misunderstandings between technicians viewing the same signal at different places. The remedy is scopes with uniform responses. To accomplish this, the *IRE rolloff* is used. This is a filter with a standard characteristic falling off as the frequency increases (Figs. 2-a, -b). Scopes so equipped give more identical level readings.

Level troubles can also occur due to picture composition. Suppose two normal cameras are used. No. 1 views an evenly lighted scene (Fig. 3-a). No. 2 views the same scene, but catches some extreme highlights such as reflections off chrome. The same condition exists on the control scopes as did with overshoot, except that now the peak (highlight) can be of lower frequency (Fig. 3-b). If such a peak is set at 0.7 volt, the rest of the scene will be darker than normal. If the control operator limits off the peak, the remainder of the scene can be increased to normal level (Fig. 3-c).

Thus far the white portions of the picture have been discussed. But the same things can exist in the black portions. In fact, black detail can be lost more easily than white. The setup (distance between the blackest portion of the picture and the tip of the blanking pulse) should be maintained at about 10% of the picture amplitude. Where different scopes exhibit different amounts of black detail, it follows the setup will also appear different.

Setup adjustments are originally made by the camera control operator. He does this by merely lengthening the blanking pulse for more setup or shortening it by clipping the black end for less. If he makes it shorter than the peak-to-peak video, he also clips off the blackest portion of the video. Thus he loses black detail and the average background becomes darker. If he wants to enhance something like white lettering on a black background, he may intentionally reduce the setup below normal. Ordinarily he holds it at 10%.

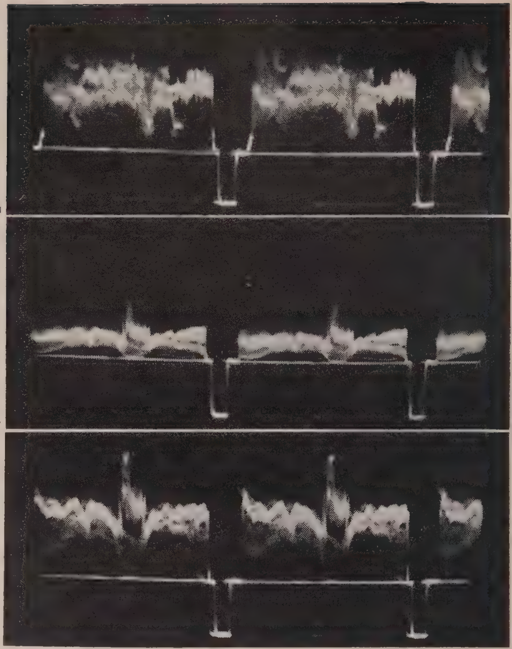


Fig. 3—*a*, An evenly lighted scene; *b*, same scene with bright reflected highlight—blacks are severely compressed; *c*, same scene with highlight limited.

But suppose he is receiving a signal from the network. Now he has no control over the height of the blanking pulse. What he receives from the network, however, can be doctored. This is done in the stabilizing amplifier, used to clean up a signal over which there is no other local control. Essentially it receives a composite signal, clips off the sync pulse, reshapes it, then reapplies it to the original signal. This sync clipper is adjustable. If it is set to clip more than the sync pulse, it clips into the blanking, reducing setup. Thus if the network signal has too much setup, the local technician can reduce it (Fig. 4).

But now if he switches to a local signal—which also goes through the same stabilizing amplifier—the setup will be too low and he must readjust the sync clipper. This also changes the apparent background brightness.

Don't blame all changes in background brightness or contrast on the control operator! Some of it is dictated by front-office economics. Image orthicon tubes for studio cameras cost over $1,000 each. Their lives are from 500 hours to (if you push your luck) 1,500. Smaller stations usually stock only a few at a time, especially since they have a finite shelf life. Of the few they stock, no two will have exactly the same contrast characteristics. Hence matched tubes are not always possible. And, vidicon cameras, popular for film pickup, may show contrast different from the orthicon cameras.

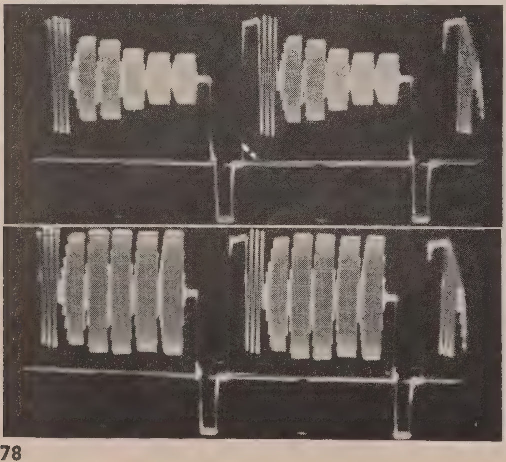


Fig. 2—*a*, Multifrequency burst — frequencies are 0.5, 1.5, 2, 3, 3.6 and 4.2 mc; *b*, burst through IRE rolloff filter.

Although the stabilizing amplifier's function is to improve the signal, it can become balky. Just as noise pulses can confuse receiver deflection oscillators, they can confuse the stabilizing amplifier. So can overshoot spikes on the edges of the pulses.

The stabilizing amplifier uses a driven clamp. The driving pulses for this clamp are made by differentiating the clipped-off sync pulse. If noise or spikes extend into the sync region, the clamp may mistake these for differentiated sync pulses, producing the wrong clamping information. This causes heavy erratic black streaking across the picture and is not uncommon when a signal is originating from some temporary point where conditions are unfavorable.

A cleaner type of streaking, similar to a loss of low frequencies, occurs

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D-30	30 w.	16	75- 7,000	4 1/16"	4 1/2"	$27.50
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Fig. 4—*a*, A normal setup; *b*, no setup; *c*, video pattern shows high setup.

when the sync pulse is delayed. Ordinarily the sync pulse starts 1.6 μsec after the start of the blanking pulse. If it starts late, the clamp driving pulses made from it will also be late. Thus clamping occurs late and may miss the flat portion of the blanking pulse on which it should occur. The result is erratic clamping. This sometimes occurs in transmitters and causes the streaking described.

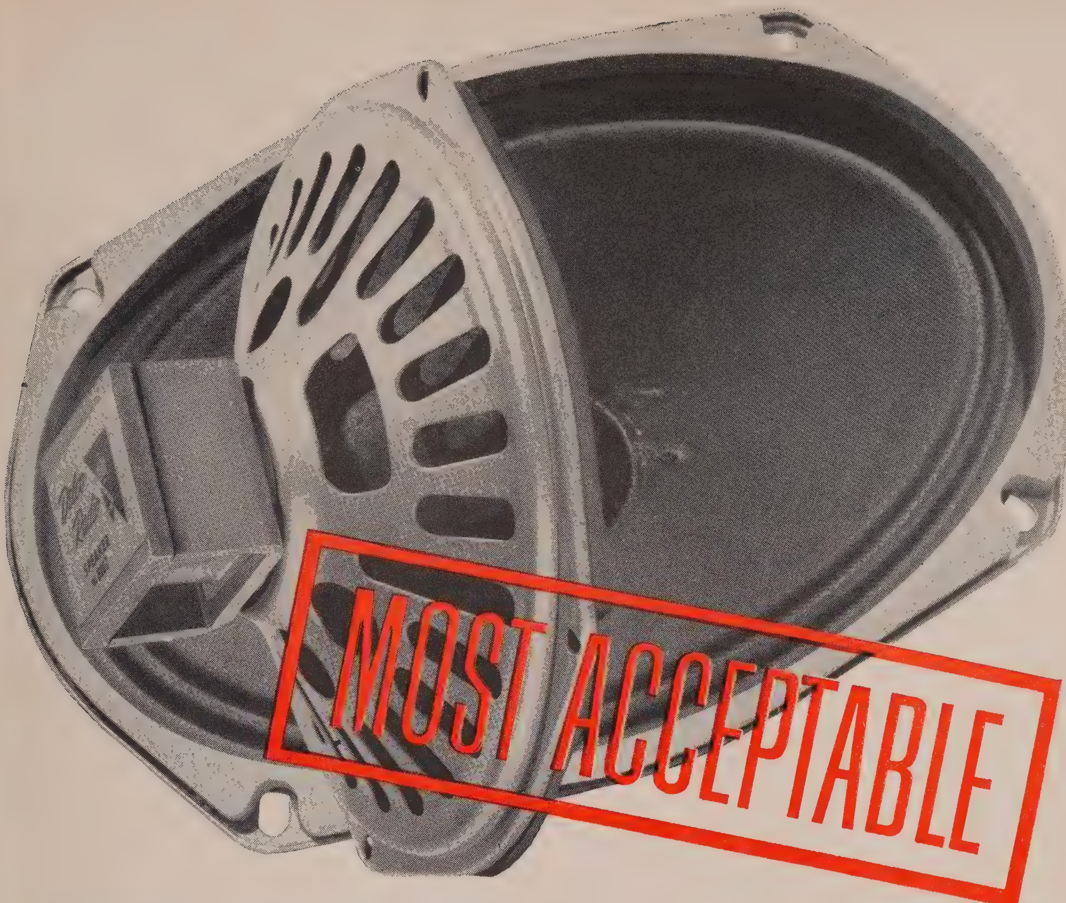
Such a delay in sync usually occurs from a routing of the sync pulse separate from the picture. It is also a function of the originating sync generator. Other troubles begin in the sync generator, too, although they are relatively uncommon. The sync generator manufactures all the pulses used. The numbers of pulses and their widths are adjustable. Usually no serious damage is done to the picture if variations in the pulses are small.

One exception is the number of equalizing pulses. There are six of these preceding the vertical sync pulse and six following. Should there be too many or too few, the vertical oscillators in the receivers may trigger at the wrong time, resulting in unstable interlace and tearing at the top of the raster. The condition of these pulses may be observed on a receiver with sufficient accuracy to detect any major discrepancies by rolling up the picture with the vertical hold control and adjusting brightness so pulses can be seen.

Sometimes the sync generator causes rubber sync at the top of the raster. These generators are often operated locked to the power company's 60 cycles. The generator originates with a 31.5-kc oscillator. This feeds a series of counters which count down to 60 cycles. The 60 cycles is then compared with the power company's in a discriminator and the correcting voltage applied to the 31.5-kc oscillator. Sometimes this circuit hunts, causing the top of the raster to wobble slightly. This is best observed by viewing the start of the first line of the interlaced field at the top center of the raster. A small pulsing variation in the length of this line is normal in some generators. If it becomes too large, wobble at the top of the picture may become noticeable.

Viewers often complain of buzz in the audio with change in picture. This of course often occurs from receiver misalignment, but can be aggravated in intercarrier sets by high modulation at the transmitter. The 4.5-mc sound if is the result of beating the picture and sound if carriers. The picture if should be large compared to the sound if carrier.

This is true when the if curve and the received signal are correct. However, the whiter the transmitted picture, the lower the picture carrier. When the picture carrier is too low, the receiver sound system cannot limit off all the video modulation passed to it. Since part of this video modulation is the 60-cycle sync pulse, there is buzz in the audio output. In high-power transmitter finals this amount of modulation is critical. It should be held so that at least 10% of the picture carrier is transmitted. END



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THE drive voltage fed to the grid of a horizontal output tube must have some definite waveshape and amplitude, depending upon the model, for normal operation. Poor waveform or either excessive or insufficient drive will not only distort the raster but can seriously damage components in the horizontal output, damper and high-voltage circuits.

The horizontal output stage is normally biased deep into cutoff. When plate current does flow, it produces horizontal deflection across the right two-thirds of the screen; damper current furnishes deflection across the left third of the screen. Thus it is at approximately this one-third point where the transition from damper to horizontal output tube current takes place. A drive line will appear when this transition is not smooth.

While grid circuit values may be selected to provide proper grid drive, many manufacturers include a drive control in the output tube grid circuit to compensate for changes in component values and voltages that otherwise, in time, may produce an annoying drive line or severe nonlinearity.

However, improper setting of this control is often more damaging than a slight change in fixed circuit values. Excessive drive can produce high-amplitude transients that the damper circuit cannot quench, producing white bars in the area where the drive line might appear. It may also produce arcing and corona in the high-voltage power supply due to increased high voltage.

Insufficient drive reduces the normal grid bias, producing excessive plate current flow. The tube, thus overheated, is shortlived and often becomes gassy. In addition, the heavy plate current of the horizontal output tube, which flows through a portion of the flyback transformer, overheats the unit as well as associated components.

Aside from the obvious drive line, improper drive setting is indicated by a picture greatly stretched at the left and somewhat compressed at the center and right; this cannot be corrected by adjusting the linearity control.

The drive control is usually a potentiometer or a mica compression type trimmer capacitor. Fig. 1 shows the grid circuit of a horizontal output stage in the Admiral 19E1, a fairly common circuit. A 10–160-$\mu\mu f$ trimmer is used. The entire input voltage is developed across C1. The trimmer and C2 in series act as a capacitive voltage divider feeding the output grid across R. The lower the capacitance of the drive control, the greater its capacitive reactance and the drive voltage developed across it.

Improper adjustment of this trimmer often causes insufficient width and brightness. For best adjustment of this and most other circuits, turn to an unused channel. Set the brightness control slightly lower than normal and turn the contrast down. Then turn the horizontal hold completely to the left. Finally, turn the horizontal drive screw to the left (out) as far as possible while still maintaining slight tension on the trimmer plate. If a white vertical line appears on the screen, slowly turn the drive screw in until the line just disappears. Do not use the drive control to obtain correct width and linearity. Leave these for the width and linearity controls.

Fig. 2 shows a later model Admiral,

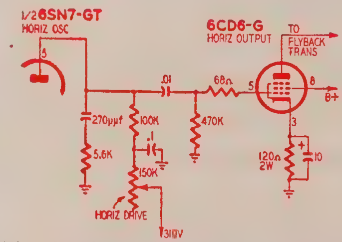


Fig. 2—The horizontal drive control is a potentiometer in this receiver.

the 23B1AZ, using a 150,000-ohm potentiometer as the drive control. This unit is in the plate circuit of the horizontal oscillator and controls the B-plus voltage on the plate of the oscillator. Being decoupled by the 0.1-μf capacitor, the drive control is not part of the oscillator plate load. By controlling the oscillator plate voltage, the drive control varies the output of the oscillator and, hence, the grid drive to the horizontal output tube.

Fig. 3 shows still another Admiral circuit—the model 20Y4D setup. Here the 170-780-$\mu\mu f$ trimmer is in series with the output grid resistor. The reactance of the .0047-μf blocking capacitor being relatively low, the oscillator output is divided between the trimmer and grid resistor. At maximum capacitance the drive control supplies maximum grid drive to the horizontal output tube because a minimum amount of voltage is developed across it.

Fig. 4 shows a variation in drive control circuitry, used in the Zenith chassis 21L21. Here, with the output tube cathode unbypassed to ground, the horizontal drive trimmer is connected between grid and cathode and acts as part of an ac voltage divider in series with the 330-$\mu\mu f$ coupling capacitor.

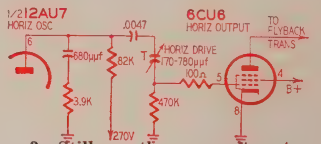


Fig. 3—Still another capacitor type horizontal drive control arrangement.

While there are some variations in manufacturers' instructions for adjusting the drive control, in general set the drive at a point just before left-hand stretch or center compression takes place. Then adjust the horizontal linearity. Where possible, a linearity generator such as the crossbar type should be used. Where the drive control does not correct the drive bar, carefully check all resistors and capacitors in the grid circuit of the horizontal output stage. Also check the amplitude of the oscillator output. Replace the horizontal oscillator tube and check all tube voltages.

Overdriving the output stage does more than apply an excessive sawtooth voltage; it will often distort the output waveform and cause the stage to oscillate, producing one or more beaded vertical lines at the left side of the picture.

The principal danger in underdriving is in not producing sufficient grid-leak bias. Most output stages use some cathode bias to supplement the grid-leak bias. This affords some protection to the horizontal output tube in case of drive failure. Without cathode bias, insufficient drive may permit very high cathode current (greater than 110 ma or so). Thus, in horizontal sweep and high-voltage problems, always make a quick check of the horizontal output stage grid circuit. Test both the sawtooth drive signal and the developed dc bias.

Ringing in raster

An Arvin chassis TE-290 came in with no picture. After correcting this

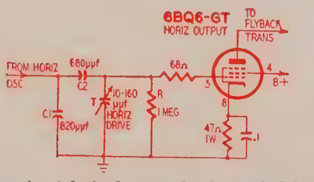


Fig. 1—Admiral 19E1 horizontal drive control circuit is used in many sets.

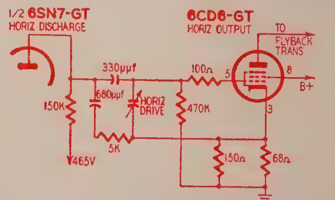


Fig. 4—A resistance–capacitance voltage divider varies horizontal drive.

defect I noticed a few vertical lines at the left edge of the screen. With the contrast turned down, the lines still appeared and I assumed the trouble to be ringing. From here on in I got nowhere. All components in the horizontal output stage and the damper circuit were checked and most capacitors replaced.

Perhaps I should not have mentioned the lines because the customer said that they were always there and did not bother him. However, having raised the issue, I would like to clear it up and would appreciate any assistance you can give.—B. T., New London, Conn.

You did not state whether you replaced the balancing capacitor in the high side of the horizontal deflection coils—if not, do so. If this does not help, try several values of balancing capacitors. Try values as low as 22 and as high as 47 $\mu\mu$f. Somewhere in this range you should hit a value that will supply the correct capacitance to balance out the capacitance of the upper winding to ground. Also try redressing leads in the damper circuit.

Vertical foldover

On an Admiral 20T1 there is a clear-cut case of vertical foldover with a bright horizontal bar at the bottom of the picture. I went through all the usual checks but cannot eliminate the bar. The waveform is distorted and the point of foldover can be seen, but the point can't be straightened out. All components have been checked in the vertical oscillator and amplifier circuits.—F. T., Toledo, Ohio

Assuming all components have been thoroughly checked, make sure the line voltage is at least 110. While most sets will operate fairly well down to 105 volts, certain troubles, such as foldover, can occur in this voltage range. I assume also that you have replaced the 6S4 vertical output tube. This tube has been the source of a great deal of trouble with some brands giving considerably more output than others—try a few of these tubes. While on the subject, replace the 5U4-G.

There are some component changes that may help. Change the 1-megohm grid resistor in the vertical output stage to 3.3 megohms. Various-size decoupling resistors were used in the plate circuit of the vertical output tube, with the most effective being a value of 560 ohms. At the factory 1,000- and 820-ohm resistors were used.

You might also try connecting a .05-μf capacitor across the width control. This will increase width slightly and provide increased vertical sweep, often curing foldover problems. The high voltage will be reduced slightly, but not noticeably.

You did not state at what point you saw the distorted waveform. If it was in the deflection yoke, the foldover may be corrected by fitting the two core pieces closely together with air gaps of 1/32 inch or less. This can be done by tightening the collar. If this doesn't

do the trick, remove the collar and iron cores and smooth over the insulation between the cores.

Defective crystal

A Sentinel model 456 came in with a complaint of sound bars. Varying the fine tuning had no effect on their number or amplitude. The picture was rather weak and sync poor. I checked the alignment of the front end and if amplifier—both checked OK. I did find a shorted video amplifier tube but replacing it helped only slightly. All components in this circuit checked normal.—T. T., Houston, Tex.

The symptoms you describe, coupled with the alignment of the rf and if circuits, suggest trouble in the video amplifier. Since you found a shorted video amplifier (6AH6) it is most likely that the trouble is a damaged 1N60 crystal detector. Actually this is a common defect; the surge current, due to the short in the grid circuit, ruins the crystal. Replace the 1N60 crystal and install a resistor of about 300 or 400 ohms between the control grid of the 6AH6 and the circuitry feeding the grid. Many other sets use a resistor here and some later Sentinels do also.

Poor vertical sync

I have an RCA model 21-D-327 set in which I have been unable to obtain stable vertical sync. The entire vertical sync section has been gone over with a fine-tooth comb from the vertical sync separator to the vertical output. All tubes have been replaced and all capacitors and resistors checked. As per instructions in your previous articles, I replaced all components that varied more than 10% from the schematic.

I even carefully checked all voltages and, as best I could, all signal waveforms. The trouble is not severe but it is annoying, especially when the entire circuit checks perfectly. One RCA distributor said the trouble was inherent in the set and that I would have to experiment with some values. Before tearing into the set, and possibly making things worse, I would like to get your ideas.—F. M., Chicago, Ill.

The RCA distributor was correct in stating that values must be experimented with in this chassis; poor vertical sync is not uncommon. Fig. 5 shows the circuit in which the trouble lies and where it can be corrected.

Try increasing the plate voltage on the plate of the vertical sync separator. This can be done by connecting R169 to the 350-volt line. Reduce R170 to about 1 megohm. Connect R235 to a 160-volt point to increase plate voltage on the vertical sync amplifier. Decrease R184 and R185 to approximately half their original values.

Strictly hit-or-miss, try connecting a small capacitor of about 68 μμf from the grid of the vertical sync separator to ground. Also, increase the value of R174 to about 75,000 ohms. In these instances observe whether the changes harm interlace or the quality of the picture. If they do, decrease the extent of the change. The above are the most probable troublemakers, further experimentation should depend upon the seriousness of the instability.

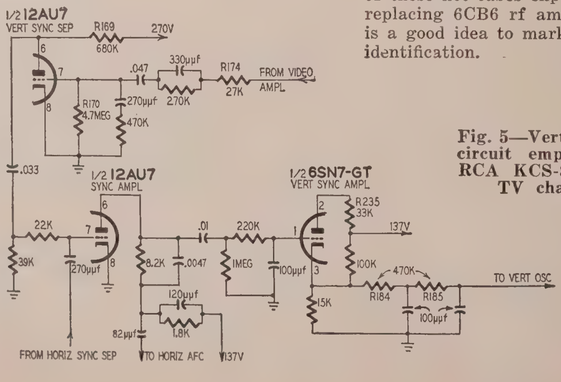


Fig. 5—Vertical sync circuit employed in RCA KCS-81 series TV chassis.

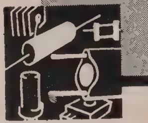
Hot 6CB6 tubes

On some Zenith series-H receivers reception can be greatly improved by interchanging the 6CB6's used in the rf and converter stages. On checking them in a tube tester they appear to be about equal in quality. I have spoken to other service technicians about this and they report the same experience. Sometimes new tubes that check slightly better on the checker do not give this great improvement. Hoping that this might help other technicians, I would like an explanation of this effect.—M. P., Amarillo, Tex.

The situation you spotted is caused by so-called "hot" tubes—tubes having a very good noise figure. Often a tube having a good noise figure is used in the converter where its benefits are not used to the extent that they would be in the rf amplifier circuit. Also, when a great improvement is noted in a receiver by making the switch it may be a good sign that the front end is badly in need of alignment. Thus, this should be done whenever the improvement is noted while the set is on the bench.

Some technicians keep a small stock of these hot tubes expressly for use in replacing 6CB6 rf amplifier tubes. It is a good idea to mark them for quick identification. END

new Devices



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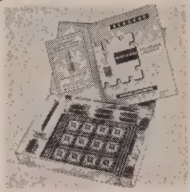
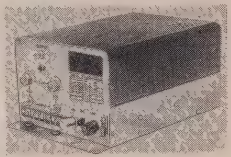


and module catalog. Layouts made by plugging modules into breadboard sockets and making connections with banana-plug jumpers plus breadboard's basic busbar wiring. — **Distributor Service Div., Aerovox Corp.,** New Bedford, Mass.

BROAD-BAND AMPLIFIER, *model 2300*, high-gain high-output type for community antenna systems. Individual gain and tilt controls for high and low bands for presetting amplifier output to compensate for cable tilt and gain. No external line equalizers needed. Universal input circuit



amplifier allows use of combinations of high and low 72- or 300-ohm antennas. 7 tubes. Covers high and low bands with minimum gain of 38 db. Maximum undistorted output for single amplifier 0.3 volt per channel for 9-channel operation—5 channels in low band, 4 in high.—**Jerrold Electronics Corp.,** 23rd & Chestnut Sts., Philadelphia 3, Pa.

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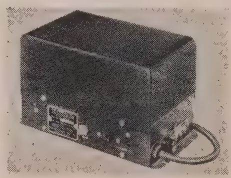

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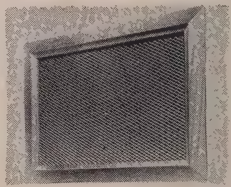
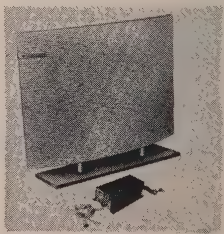


and Goodmans Axiom 22 Mk. II, Axiom 150 Mk. II, Axiom 60 or Audiom 60 or Audiom 70 speakers; *model 480* for four Goodmans Axiom 80 speakers; *model 280* for two Goodmans Axiom 80 speakers; *model 180* for one Goodmans Axiom 80 speaker.—**Rockbar Corp.,** 650 Halstead Ave., Mamaroneck, N. Y.

ELECTROSTATIC SPEAKERS. *Model 580 (Isophase)* reproduces frequencies from 1 to well above 30 kc. Use with woofer providing response from lower limit up to 1 kc. Maximum power rating 12 watts at 16 ohms, 25 watts at 8 ohms. 22 x 15 x 6 inches, 4⅝ pounds. *Model 581 (Isophase)* (larger of two) re-

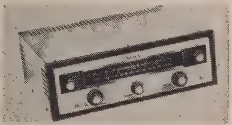


produces from 400 to well above 30,000 cycles and requires woofer with range up to 400 cycles. Maximum power rating 25 watts at 16 ohms, 50 watts at 8 ohms. 36 x 28 x 8½ inches, 16⅝ pounds. Isophase speakers provided with *Isophase model 401-D* divider consisting of crossover network and power supply.—**Pickering & Co., Inc.,** Oceanside, N. Y.

CERAMIC PHONOGRAPH CARTRIDGES *3 Series.* Turnover type *3T* (illustrated) plays

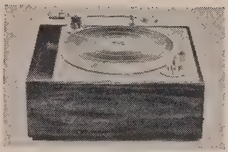
records of all speeds. Diamond needles recommended, but available with sapphire needles. Jet black and gold. Equalizers and preamplifiers not needed.—**Sonotone Corp.,** Elmsford, N.Y.

3-IN-1 HI-FI SYSTEM, *model HF-41,* FM-AM tuner, preamplifier and 20-watt amplifier. Built-in rumble filter; variable loudness control; tape head play-



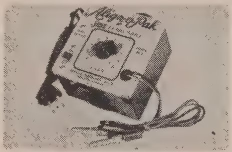
back, output, and equalizer; 4-position record equalizer, flywheel tuning; afc and afc defeat; variable phono load; 4 inputs; dc on filaments of preamplifier tube. 14¾ x 14 9/16 x 12⅛ inches.—**Pilot Radio Corp.,** 3706 36th St., Long Island City 1, N. Y.

TURNTABLE BASE, *Rondine,* rests on rubber ball feet adjust-



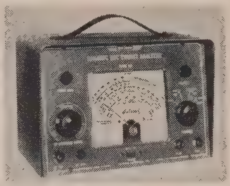
able for leveling. 16½ inches wide, 17 inches deep and 6 inches high. Turntable deck rests on built-in ledge. Accommodates Rondine or Rondine deluxe turntables. Walnut or natural Korina, handrubbed to satin finish.—**Rek-O-Kut Co.,** 38-01 Queens Blvd., Long Island City, N. Y.

BIAS SUPPLY, *Align-O-Pak model BE3,* provides any voltage from 0 to 18, positive or nega-



tive. Two units may be used in series for higher voltages.—**Service Instrument Co.,** 171 Official Rd., Addison, Ill.

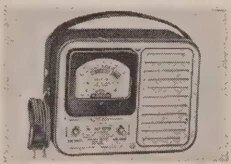
DYNAMIC AGC CIRCUIT ANALYZER, *Win-Tronix model 825.* Agc test signal is fed to antenna of TV receiver. Monitor circuits determine whether trouble is due to agc and isolate agc troubles. Checks agc action; substitutes agc bias; checks agc opens, shorts and ohms, tests gated agc circuits. Vtvm circuit to measure dc and ac voltages.—**Winston**



Electronics, Inc., 4312 Main St., Philadelphia 27, Pa.

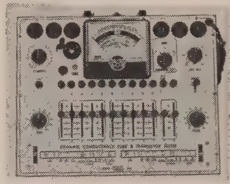
IN-CIRCUIT TESTER, *model 383-A Capacohmeter,* locates 7 out of 10 defective capacitors in circuit. Tests shunted and coupling paper, mica and ceramic capacitors. Capacitance indicated directly on meter scale over range of 10 $\mu\mu$f – 10μf. Most capacitance values can be measured in circuit, all out of circuit. Uses pulse test. 9 pounds.—**Simpson Electric Co.,** 5200 W. Kinzie St., Chicago 44, Ill.

LINE-LOAD SURVEY METER, *model AC-12,* Three test loads check ability of 110-volt ac lines



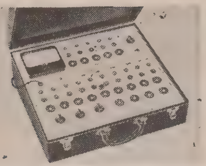
to handle loads imposed by air conditioners, broilers, etc. Line-load conditions indicated directly as low, OK or high. Also reads actual line voltage. 5⅞ x 7¾ x 3¼ inches, 5 pounds.—**Precision Apparatus Co., Inc.,** 70-31 84th St., Glendale 27, N. Y.

TUBE AND TRANSISTOR TESTER, *model 666.* For n-p-n and p-n-p transistors—leakage measurement of collector current and direct reading of current amplification factor or Beta. Tests all receiving tubes including subminiature, special-purpose, series-string 600-, 450- and 300-ma types; color and mono-



chrome picture tubes with accessory adapter. Composite indication of mutual conductance and peak emission. 200-μa meter. 10 6-position lever switches for free-point connections. 10 push-buttons for inserting tube element in leakage circuit, selecting of individual tube sections. Leakage test reads interelement leakage in ohms.—**Electronic Instrument Co., Inc.,** 84 Withers St., Brooklyn 11, N. Y.

ULTRA-FAST TUBE CHECKER, *model 116,* factory-wired or



kit. Emission and mutual conductance tests for most tubes. Can plug in five tubes at once and test each separately. Checks transistors, gas, life and individual sections of multipurpose tubes. — **Precise Development Corp.**, Oceanside, Long Island, N. Y.

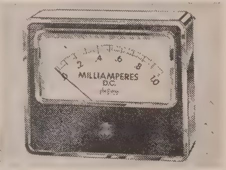
WIREWOUND CONTROLS for printed-wiring assemblies. Redesigned version of *series 39 Humdinger* control.

Mounting by two tabs for positive locking to printed-wiring board. 2 watts. Resistance range 4–5,000 ohms. ¾ inch in diameter, ⅜ inch deep. Screwdriver adjusted.—**Clarostat Mfg. Co., Inc.**, Dover, N. H.

WIREWOUND CONTROL, *model WW*, packs 5 watts into 2-watt size. 290° rotation. 1 3/32 inch diameter by 9/16 inch deep. Anodized aluminum shaft, ¼ inch diameter, 3 inches long—⅜ inch x 32 thread. 1 to 15,000

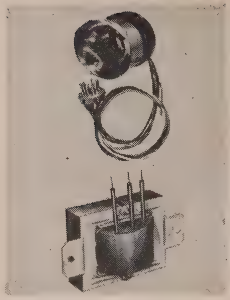
ohms.—**Centralab, Div. of Globe Union,** 900 E. Keefe Ave., Milwaukee 1, Wis.

CUSTOM PANEL METERS IN COLOR to match or blend. Metal cases will not chip, shatter or



warp, and give antimagnetic shielding to meter. Insulated zero adjustments. In all standard ranges and may be ordered with special ranges and scales. —**Phaostron Instrument & Electronic Co.**, 151 Pasadena Ave., So. Pasadena, Calif.

2 REPLACEMENT TV TRANSFORMERS. Exact electrical and physical replacements. Deflection yoke *DY-23A* replacement for RCA part 972459-2-3; can be used in 27 KCS96 and KCS97 chassis models. *A-8150* vertical output transformer replaces RCA part C971798-1 in 6 chassis

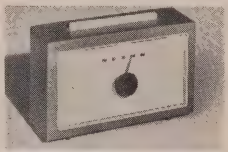


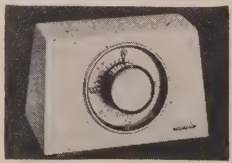
and 89 models.—**Chicago Standard Transformer Corp.**, 3501 W. Addison St., Chicago 18, Ill.

UHF–VHF INTERACTION FILTER, *Ultra-Tie*, joins vhf and uhf antennas for use with single transmission line. Performs with leads of any length. May be used

in conjunction with *SelecTenna* system to join as many as 7 antennas to single transmission line. Can separate uhf and vhf signals at TV set or converter. U type mast clamp.—**Channel Master Corp.**, Ellenville, N. Y.

ANTENNA ROTATORS, *Alliance T-12* (top) and *U-98 Tenna-Rotors* (bottom)

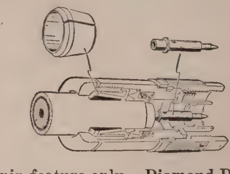




are now available with control boxes in forest green and ivory as well as in the standard mahogany-grain finish.—**Alliance Mfg. Co.**, Alliance, Ohio.

CONICAL ANTENNAS, *Taco Turret series.* Comprises 8 single and 8 stacked models. Designed to maintain accurately element spacing and forward angle.—**Technical Appliance Corp.**, Sherburne, N. Y.

COAXIAL CONNECTORS, *N series.* High-frequency range 10,000 mc. Collet clamping device withstands twice standard pull-out force required by MIL specifications. Series N plug, jack and panel jack available with locked-

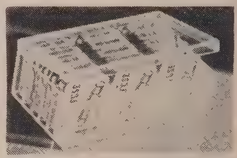


pin feature only.—**Diamond Div., Cannon Electric Co.**, 7 North Ave., Wakefield, Mass.

HAND TOOL, *Tension Tweezie.* Holds small electronic part;

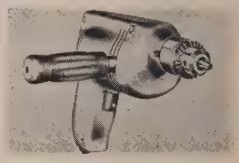
reaches into cramped quarters. Tension feature holds without finger interference or pressure. —**Hunter Tool**, Box 564, Whittier, Calif.

PLASTIC FUSE CADDY, *094037*, individual compartments for 18 types of fuses and assortment of



15 types including LC or limited-current line type—(three compartments vacant). Fuses handle all normal TV and radio replacements. **Littelfuse, Inc.**, Des Plaines, Ill.

⅜-INCH POWER DRILL, *model 707*, geared down to speed suitable for all types of drilling including stone, brick, marble and cement. Universal ac–dc 2-amp



motor. Overall length 9 inches, height 6 inches. 1,100 rpm with no load, 800 rpm when under load.—**Wen Products Inc.**, 5804 Northwest Highway, Chicago 31, Ill. END

All specifications given on these pages are from manufacturers' data.

SALE Priced for A SELL-OUT!

EVERYTHING GOING regardless of cost • • •
• • • At the MOST SENSATIONAL *PRICE SLASHING EVER*

MFRS—EXPORTERS—DEALERS—MECHANICS • this is THE OPPORTUNITY that knocks once.

"Many values a **DOLLAR** for a **DIME**" on **FACTORY BRAND NEW MERCHANDISE** sold to you with a **MONEY BACK GUARANTEE** . . . All American Made (nothing foreign). Some items in thousands, others in limited quantities. Get your share by rushing your order in. We will gladly send you illustrations and descriptions on Radios, TV, Cabinets, Tools, Test Equipment, Etc. Send 20% deposit with order, balance C.O.D.

TUBULAR CONDENSERS—85° C
TOP QUALITY—Equally as good for TV or Radio Work

.01—100v, .02—100v, .1—100v, .25—100v, .002—200v..........1c ea.
.1—200v, .25—200v, .47—200v, .002—400v, .004—400v..........2c ea.
.006—400v, .02—400v, .03—400v, .001—600v, .002—600v........2c ea.
.01—400v, .047—400v, .1—400v, .01—600v, .0022—600v.........4c ea.
.047—600v, .1—600v, .25—600v, .001—1000v, .01—1000v........5c ea.
.039—1000v, .05—1000v, .05—1600v, .005—1700v, .01—1700v....8c ea.
.1—1000v, .02—1700v, .05—2500v, .01—6000v, .05—6000v......12c ea.
.0005—7500v, 100—6v, 100—50v, 1—150v, 16—200v, 20—350v..14c ea.
30—450v, 40—450v, 80—150v, 50/30—150v, 80/50—450v.......35c ea.

CARBON RESISTORS
Regular factory stock in, Stackpole, I.R.C. Speer. Deduct 10% on lots of 100 or over

½ WATT 10% 20, 68, 82, 100, 150, 270, 330, 390, 470, 560Ω....2c ea.
½ WATT 10% 680, 1K, 1800, 2700, 3900, 4700, 5600, 6800Ω.....2c ea.
½ WATT 10% 8200, 10K, 18K, 22K, 50K, 120K, 150K, 330KΩ......2c ea.
½ WATT 10% 470K, 1meg, 3.9meg, 4.7meg, 6.8meg, 10megΩ.....2c ea.
1 WATT 10% 2.2, 3.3, 5, 15, 39, 220, 390, 470, 3300, 3900Ω...3c ea.
1 WATT 10% 1K, 10K, 15K, 18K, 22K, 27K, 39K, 120K, 470KΩ....3c ea.
2 WATT 10% 3.3, 100, 270, 470, 1K, 1800, 22K, 100K, 470KΩ....4c ea.
WIREWOUND RESISTORS 5K-5W 100-5W 500-10W 10K-5W 8500-10W 16c ea.
CERAMIC CONDENSERS 1, 2, 3, 5, 6, 10, 25, 47, 50, 51, 56, 68, 82 mmf 3c ea.
CERAMIC CONDENSERS 100, 120, 220, 270, 330, 470, 1000, 2500, 6800 mmf 3c ea.
MICA CONDENSERS 5, 25, 30, 60, 75, 100, 120, 150, 220, 250 mmf. 3c ea.
MICA CONDENSERS 270, 330, 470, 560, 680, 820, 1K, 1500, 2K, 3K, 6K mmf .3c ea.
¼ AMP FUSES #3AF......1c ea. **PILOT LIGHTS** #44, 46, 47, 51......5c ea.
PM SPEAKERS 4".......79c 5".............99c 6"..............$1.29
PM SPEAKERS 8"....$1.99 10"..........$2.68 12"............. 2.99
OVAL PM SPEAKERS 4" x 6"........98c ea. 6" x 9" $2.87
AUDIO OUTPUT TRANSFORMERS (50L6)...29c 6K6......34c 6V6 . .39c
$2 PUSH PULL AUDIO OUTPUT TRANSFORMER (6V6, 25L6, 50L6)..59c ea.
SELENIUM RECTIFIERS 65ma......38c, 75ma......42c, 100ma......54c 150ma 68c
SELENIUM RECTIFIERS 250ma ...89c, 300 ma....99c, 350 ma....$1.07, 450ma.$1.29
$25 #471 REGAL AC-DC 5-tube RADIO, complete ready to play.........$10
$32 #445 REGAL CLOCK RADIO, complete ready to play................$17
$27 #707 REGAL AC-DC RADIO, complete ready to play $12
$30 #271 REGAL AC-DC RADIO with sweep dial, complete ready to play . .$14
$84 #P-175 REGAL ROUND-THE-WORLD RADIO, complete ready to play .$35
DEWALD TRANSISTOR PORTABLE RADIO, complete ready to play.......$39
HALLICRAFTER TRANSISTOR PORTABLE RADIO, complete to play.....$46
HALLICRAFTER ROUND-THE-WORLD PORTABLE RADIO, complete.....$119
$60 AUTOMATIC CUSTOM-BUILT AUTO RADIOS, complete ready to install for FORD, 1949, 50, 51, 52, 53, 54, PLYMOUTH, 1951, 52, 53, 54, 55, HENRY-J, 1951, CHEVROLET, 1953, 1954, better rush your orders..only $25 ea.
$40 AUTO SHORT WAVE TUNER incorporates SW on any above radios.....$10
$9 AUTO 3-SECTION ANTENNA, complete with lead-in..................$2.45
4 PRONG AUTO VIBRATOR, non synchronous type for most cars.......99c ea.
$1 CHROMIUM 10 SIZE HEX NUT WRENCH, finest type made .....19c ea.
HEAVY DUTY JIFFY SOLDERING GUN, 250 WATTS...............$8.64
ROSIN CORE SOLDER Economy type 49c lb Finest 40/60 type. .79c lb.
HYTRON TOOLS Tube Lifters Auto Tools. Tube Tappers ....3c ea.
ELECTRIC PORTABLE POWER SAW invaluable for any workshop.......$19.97
POWERFUL ELECTRIC HAND DRILL chuck takes up to ⅜" Bit........$17.97
ELECTRIC SANDER-POLISHER straight line whip-free action...........$9.30
STEEL WALL CABINET with 16 see-through lucite drawers..............$5.48
$40 SUPERIOR TV BAR GENERATOR creates TV pattern on TV Set.........$25
JIFFY TUBE TEST METER, better than any that sell for $200..............$89
$25—3-SPEED PORTABLE PHONOGRAPH, complete ready to play........$13
$15 PHONO AMPLIFIER, including 3 tubes...............................$5
3-SPEED PHONO MOTOR, including turntable and accessories..............$4
3-SPEED PICK-UP TONE ARM with concert tone flip-over cartridge.........$4
$2 SAPPHIRE PHONO NEEDLE, 4000 playings..........................39c
ASTATIC CRYSTAL # L82 $1.59. RCA CRYSTAL CARTRIDGE # 9890 .$1.69
PHONO MOTOR, 78 RPM including turntable and accessories $1.78
ANSLEY 2-SPEED RECORD CHANGER, complete with pick-up..............$5
GI 3-SPEED RECORD CHANGER, complete with pick-up.................$10
WEBSTER 3-SPEED RECORD CHANGER pick-up with flip-over cartridge....$20
$50 #PA912 PILOT PRE-AMPLIFIER, complete with tubes................$29
$25 ELECTRONIC GUARDIAN, adds as Inter-Comm. on your Radio.........$10
$25 SUPER HET TUNER for use on TV, Phono or Amplifier w/tubes.......$6.99
6-FOOT LINE CORDS, complete with plug ....9c ea.
I.F. TRANSFORMERS, 456KC also FM type 10.7mc....................29c ea.
2 GANG VARIABLE CONDENSERS 420/162.............................39c ea.
2 GANG VARIABLE CONDENSERS (FM) 88 to 108mc......................39c ea.
FINEST DIAL CORD, 25 ft.....24c; 50 ft.....39c; 100 ft..............69c
½ MEG CONTROL with switch..........39c ea. Control extension shaft. .5c ea.
ANTENNA LOOPS oval type....29c **LOOPSTICKS** ferrite type .39c
SPEAKER CONNECTOR PLUGS both male and female with wired leads, set. .39c
PILOT LIGHT SOCKETS bayonet type with wired leads..................9c ea.
WAFER SOCKETS for Radio or TV, miniature or octal....................3c ea.
MOLDED SOCKETS for Radio or TV, miniature or octal...................5c ea.
HARDWARE KIT, assorted screws, nut, rivets and washers...................69c
TV WIRE & SOLDER KIT..99c
10—TV ASSORTED COILS, Synchroguide, peaking, width, etc...............99c
10—ASSORTED TV ELECTROLYTIC CONDENSERS........................$4
10—ASSORTED RADIO ELECTROLYTIC CONDENSERS......................$2
50—ASSORTED RADIO KNOBS, screw and push-on............................$1
50—ASSORTED TERMINAL STRIPS, 1, 2, 3 and 4 lug types.....................$1
10—ASSORTED VOLUME CONTROLS, less switch, popular types..............$1
10—ASSORTED VOLUME CONTROLS, with switch, popular types...............$2
100—SMALL PEANUT TUBE CARTONS, 1" x 1" x 2⅛" (6AL5 size).......79c
100—LARGE PEANUT TUBE CARTONS, 1" x 1" x 2¾" (35W4 size)........94c
100—GT TYPE TUBE CARTONS, 1¼" x 1¼" x 3⅜" (50L6 size).......$1.04
100—SMALL G TUBE CARTONS, 1½" x 1½" x 4½" (1B3 size).........$1.29
100—LARGE G TUBE CARTONS, 2" x 2" x 5" (5V4 size)...............$1.59
100—EXTRA LARGE TUBE CARTONS, 2¼" x 2¼" x 6½" (6BG6 size) . .$2.67
NEEDLE CUPS, 6/32 Wingnuts, 8/32 Wingscrews, Fancy Rosettes. .1c ea.
KNOB SPRINGS, Escutcheon Springs, #8/32 Self Tap Screws.....3 for 1c
10KV CARTWHEEL CONDENSER, list $1.75, discount 97%. Your price . .5c ea.

21" TV OPEN MASK, list $3.50, discount 90% in lots of 20 at only. .35c ea.
TV ION TRAP, latest type, good for all TV Sets, list $1, only.............10c ea.
69c TV CHEATER ELECTRIC LINE CORD, with both plugs..........21c ea.
$3 PICTURE TUBE BOOSTER, brightens, adds life to CRT..............69c ea.
UNIVERSAL CRT MOUNTING BRACKETS for all tubes from 12½" to 24" $4.97
PULSE KEYED AGC KIT, complete set of parts, 6AU6 & instructions.......$2.99
$33 21" TV CONVERSION KIT, complete set of parts for all TV Sets $12.97
$39 27" TV CONVERSION KIT, complete set of parts for all TV Sets $14.98
STANDARD CASCODE TUNER with all parts needed for assembly $15.97
UHF STRIPS for above, list price $11.90, your price $1 the following numbers available—33F, 34F, 38F, 39F, 40F, 45F, 46F, 48F, 49F, 54F, 55F, 59F, 67F, 71F, 78F, 34K, 39K, 45K, 48K, 54K, 55K, 56K, 57K, 59K, 61K, 73K, 14Q, 17Q, 28Q, 30Q, 33Q, 36Q, 38Q, 39Q, 41Q, 42Q, 45Q, 46Q, 51Q, 54Q, 55Q, 57Q, 59Q, 61Q, 66Q, 69Q, 73Q. Your choice any or all ....$1 ea.
OSCILLATOR VHF STRIPS, any channels 2 to 13 in F or Q series.......69c ea.
$1 DETENT for TUNER at only....................................19c ea.
#630 SUPER DELUXE 21" TV KIT, complete with tubes (less CRT) $94.99
GEM TV TABLE MODEL CABINET, mahog. for any TV fitting..........$35.91
AMERICAN STANDARD PICTURE TUBE 17" #17BP4 1-Yr Guaranteed.$17.56
AMERICAN STANDARD PICTURE TUBE 17" #17HP4 1-Yr Guaranteed.$19.95
AMERICAN STANDARD PICTURE TUBE 20" #20CP4 1-Yr Guaranteed.$22.74
AMERICAN STANDARD PICTURE TUBE 21" #21EP4 1-Yr Guaranteed.$23.18
AMERICAN STANDARD PICTURE TUBE 24" #24CP4 1-Yr Guaranteed.$39.89
AMERICAN STANDARD PICTURE TUBE 27" #27EP4 1-Yr Guaranteed .$54.72
$6 INDOOR V-TYPE ANTENNA, new panarama high gain type..........$1.49
$9 INDOOR ANTENNA, deluxe model with selector switch...............$2.99
$12 INVERTED V ROOF ANTENNA, new jiffy type mount $3.46
$20 DOUBLE CONICAL ANTENNA, special for fringe areas................$5.44
NEW TYPE SELF LOCKING MASTS in 5 foot lengths................59c ea.
$16 INLINE SUPER YAGI ALL CHANNEL ANTENNA, highest gain..........$8
$50 SKY CHIEF ANTENNA ROTATOR, flick of button for any station......$21
$1 TV ANTENNA RATCHET GUY WIRE TIGHTENERS..............39c ea.
100' TWIN LEAD-IN 300 OHM TRANSMISSION WIRE, top quality......99c
100' RG-59/U COAXIAL CABLE WIRE 72 OHMS, top quality.........$3.99
$24 TV POWER TRANSFORMER, universal type 250ma incl. schematic.....$4.86
$10 TV FLYBACK TRANSFORMER, universal 1B3 type incl. schematic ...$2.99
$11 COSINE 70° DEFLECTION YOKE with wired network incl. schem....$2.99
$5 VERTICAL OUTPUT TRANSFORMER, 10 to 1 ratio for most TV Sets 99c
$3 VERTICAL BLOCKING TRANSFORMER, universal type for most TV Sets .59c
$14 18KV FLYBACK TRANSFORMER, universal type for 90° CRT's $5.24
$15 COSINE 90° DEFLECTION YOKE, universal with wired network.....$5.98
$8 60° DEFLECTION YOKE, complete with wired network.................99c
NEW TYPE CARTWHEEL CONDENSERS 20KV..........39c ea. 30KV. . .59c ea.
TV FOCUS COILS 247Ω, 360Ω, 425Ω, 470Ω, 1000Ω, 4000Ω your choice . .$1.97 ea.
$5 CHOKE TRANSFORMERS, 62Ω, 250Ω, ...99c ea.
$9 RCA TYPE #211T5 FLYBACK TRANSFORMER, exact replacement . . .$2.99
$12 RCA TYPE 211T5 FLYBACK TRANSFORMER with AGC incl. schematic.$4.48
$34 PHILCO #3-TB3 TV BOOSTER, complete with tubes...............$9.72
TV RATIO DETECTOR, 4.5mc used in majority of TV Sets...................99c
TV SYNCHROLOC TRANSFORMER, #208T8 for #630 and other Sets 99c
TV SYNCHROGUIDE TRANSFORMER, RCA type 205R1....................99c
TV POPULAR TYPE 1st or 2nd SOUND I.F. TRANSFORMER.......68c ea.
$15 TV #630 CHASSIS PAN, cadmium plated with sockets on $3.96
NEW TYPE TV CHASSIS PAN, universal mounts horiz. vertical.........$5.79
$35 COMPLETE 21" FRONT END TV CABINET, for flush to wall mounting16.84
24" TV OPEN MASKS 22" x 26"....................................$2.47
27" TV OPEN MASKS 21½" x 27¼..................................$3.97
TV LUCITE MASKS 17" $3.98 21" $5.16 24" $11.84 27". .$12.49
$1 TV PLASTIC CUP for recessing neck of picture tube 3½" x 4½" diam......12c
COMPLETE SET OF TV KNOBS for #630 and used on many TV Sets........99c
COMPLETE SET OF DECALS for front knob panel of TV Set ....9c set
TV 16" OPEN MASK, rectangular gold type in lots of 20...............10c ea.
TV SAFETY GLASS 13⅜x16½"....69c, 16x22"....$4, 18x23½" $5, 21½x26½ .$6
TV ANODE LEADS, 18" long completely wired with clip...............16c ea.
TV CRT SOCKETS, 18" long completely wired ....18c ea.
$2 TV DUAL VERTICAL & HORIZONTAL CONTROL, 50K—1meg 46c
$2.50 TV PICTURE & SOUND CONTROL, 10K—1 meg with switch 89c
$2 TV FOCUS CONTROL, 1500 ohms, 4 watts 67c
TV HEIGHT CONTROL 2.5 meg . .**TV BRIGHTNESS CONTROL 50K**. .29c ea.
TV HORIZ. CENTER CONTROL. .TV. VERT. LIN. CONTROL 5000Ω. .29c ea.
TV VERT. LIN. CONTROL 5000Ω..29c
TV VERT. CENT. CONTROL 20Ω...29c
TV HORIZ. DRIVE CONTROL 20K...29c
TV TAKE-OFF COIL for Standard Front End Tuner 86c
TV CORONA RINGS.......2c ea. TV CORONA BUTTONS......3 for 1c
TOGGLE SWITCHES SPST. 24c ea. DPDT ....39c ea.
TV TUNING SHAFT BRACKETS—TV WIDTH BRACKETS.............9c ea.
$2 UNIVERSAL AGC COIL #1R4AG with instructions and diagrams.....69c ea.
TV HORIZONTAL TRIMMER replaces horizontal drive control 40-103mmf......29c
TV 2 MEGOHM RESISTOR for use in high voltage section....................69c
$2 TV DOUBLE ION TRAP...39c
TV HIGH VOLTAGE SOCKET ASSEMBLY for 1B3 tube.......................38c
TV PIX. I.F. CONVERTER COIL 20 to 25 meg with sound take-off 21.25mc . . .69c
TV 4 CONDUCTOR LEAD-IN WIRE has many useful purposes. 100 ft. for. .$1.82
$75 HI-FI CABINET with slide for Webster changer, amp. & skr. space $29.44
$50 HI-FI ENCLOSURE including 4 speakers $19
$12 TV METAL TABLE, jewelry brass finish, casters, adjusts for any TV $7
$2.50 FINE TUNING SHAFT for Standard Coil Tuner 69c
INTERLOCK SAFETY CONNECTOR. . 9c YOKE CENTERING RING....39c
VOLTAGE DIVIDER RESISTOR 1360/230 ohm—20 watts 89c
$7 TV COUPLER connects up to 3 TV Sets to 1 antenna $2.96
$18 #630 COMPLETE VIDEO & I.F. KIT, 19 items.........................$4.99
#630 TV VARIABLE CONTROL KIT, 9 controls...........................$3.97
#630 CARBON RESISTOR KIT, 107 resistors..............................$3.86
#630 WIREWOUND RESISTOR KIT, 4 resistors.............................$1.76
#630 BRACKET AND SHIELD KIT, 18 items.................................$5.78
#630 ELECTROLYTIC CONDENSER KIT, 6 condensers.......................$4.96
#630 TUBULAR CONDENSER KIT, 38 condensers............................$3.63

BROOKS RADIO & TV CORP., 84 Vesey St., Dept.A, New York 7, N.Y.
TELEPHONE COrtland 7-2359

The September issue of RADIO-ELECTRONICS on sale Aug. 23

new Records MONITOR

Popular tapes

These make a rather good case for pre-recorded tape and, indeed, some of them have first-rate quality though no really spectacular hi-fi material.

Jazz Lab
Frank Comstock and Band
Jazztape (Omega)
4004 (7½ ips 5-inch reel) $5.95

Ten more or less improvised selections by a more or less modern-jazz band, this is one of the two best demonstration and showoff tapes which have so far reached me. Some good bass, percussives and plenty of highs of all sorts. The overall quality equals that of all but the very finest discs.

Smith-Glaman Quintet
AV-252B (7½ ips 5 inch) $7.95

The quality is good but the music is so innocuously "tearoom" that it gives one nothing to shout about. A heavy bass and some excellent guitar highs and transients.

Songs of Mabel Mercer
With piano and traps
Atlantic AT 5-4 (7½ ips 5 inch) $6

Livingston Electronics, probably the most ambitious entry in the tape field, has arranged to tape the catalogs of several small disc recording companies including Atlantic, Audiosphere, Connoisseur, Empirical, Esoteric, Oceanic, Riverside and now Vanguard and Hack Swain. Presumably these include some very worth-while recordings but for some unfathomable reason they sent me this. Mabel Mercer is a blues singer vaguely in the tradition of Bessie Smith but she doesn't send me in the slightest. The recording is excellent with a very high degree of presence but there is nothing in the program material or the delivery to make it worth listening to for demonstration purposes.

Jack Teagarden's Original Dixieland
Tape of the Month Club No. 104 (7½ ips 7-inch TR) $5.95, Radio City Station Box 195, New York, N. Y.

The Tape of the Month Club is more than a year old and presents the best bargain in tapes so far. The quality of the first few recordings, however, is little better than that of the best 78 shellac discs or the first LP's. This is the best of the lot and is worth adding to a jazz-lover's library just for the historical value. The equalization, however, is not standard; it needs treble boost but unfortunately when it receives the boost the noise is high and there is much too much audible IM. Perhaps this was dubbed from old disc masters. Here is an excellent idea and if the management will only find some good program matter and record it with adequate quality the idea can go far.

Tab Smith and His Orchestra
Swain-A-Phonic Musicon No. 560
(7½ ips 7-inch TR) $9.95

Hack Swain Studios, one of the pioneers in this field, has a library of several dozen reels, mostly organ music for restaurant and skating-rink programs. This small combo features Tab Smith's sax and the quality is pretty fair but nothing to shout about. The Hack Swain line will henceforth be released and distributed by Livingston.

Irish Demonstration Tape
ORRadio Industries, Opelika, Ala.
(7½ ips 5 inch) $4.95

ORRadio produced this tape to offer to exhibitors at last fall's audio fairs and if you were there you no doubt heard it a dozen times. All things considered this is the best available demonstration tape. It has a little of everything: orchestra, strings, organ, percussion, voice quartet, etc. The percussion band is excellent and the whole makes an excellent though not overwhelming impression.

Fidelity Unlimited
Omegatape D (7½ ips 5 inch) $1

This is the biggest bargain in demonstration tapes and all in all has excellent quality and will make an impression. It contains very abbreviated excerpts from the Omegatape library plus a test track with a head alignment tone, volume level, quick frequency and speed check.

Musicon Special Selections
Swain Musicon DR-2
(7½ ips 7 inch) $9.95

Excerpts from the Musicon tape library. Nothing startling in content or quality.

Dubbings Test Tapes
D-110 (7½ ips 5 inch)
D-111 (15 ips 7 inch)

I believe these are the only "universal" test tapes which provide material for testing and adjusting tape recorders, although some manufacturers of recorders offer test tapes and the Ampex test tape is recorded to NARTB standards. Both these tapes contain material for testing wow and flutter, frequency response, signal level, signal-to-noise ratio and tape speed, plus a signal for head azimuth alignment. The 15-inch tape is recorded to NARTB standards and will serve most semiprofessional and professional recorders which usually have both 7½- and 15-ips speeds. The 7½-ips reel, however, is not recorded to NARTB standards but rather to a compromise standard which, according to Dubbings, will apply to most home type machines. The latter, therefore, does not give an accurate check of response to the NARTB equalization. Still it will give a good idea of tape performance.

Note: Records below are 12-inch LP and play back with RIAA curve unless otherwise indicated.

CHOPIN: ***Les Sylphides***
STRAUSS, JOHANN, JR.:
Graduation Ball
Arthur Fiedler and
Boston Pops Orchestra
RCA Victor LM-1919

Gaité Parisienne by the same combination was one of the most notorious examples of hi-fi unbalance—all high highs and little bass. This, however, is nicely balanced though the bass will better suit those who like it moderate than those who like it big. *Les Sylphides* is a very pleasant and bright version of this delightful and popular ballet, with touches of nice clean high highs and a fairly spectacular finale. *Graduation Ball,* a recent ballet based on Johann Strauss, Jr. music arranged by Antal Dorati, provides excellent demonstration and showoff material throughout but particularly in the *Perpetual Motion* and finale, with plenty of tinkling, good sharp snares and a very respectable drum. Sure to please.

Steel Band Clash
Cook Long Play 1040

The first of the Cook recordings of the steel bands in the West Indies was an immediate hit. This practically hand-tailored demonstration material should please at least equally well those who like both bass and high highs big. The bass is tremendous and the maracca high highs always sharp, clean and loud. In this disc we have music by three bands: Brute Force (which did the first record), Hell's Gate and Big Shell. It is interesting to compare the tonalities of the three. The most remarkable thing to me continues to be the gutty quality of the oil-drum basses in the Brute Force band.

Chinese Opera
Peking Opera
Angel 35229/L

Those who like the unusual in music and sound will welcome this disc which presents excerpts from Chinese operatic works arranged and performed in a style calculated to make the best impression possible on the Western mind. The presence is outstanding, especially on band 1 side 1, in which a remarkable performer on the Chinese oboe presents some charming imitations of birds. The tonal qualities are extraordinary and will require a very clean high end to be pleasant. There are some excellent and very different transients, some very strange voices and an assortment of Chinese instruments.

The music and tonalities are not nearly as strident and monotonous as previous samples of Chinese music. This is especially true of the *Dance to a Drum* on side 2, lovely music which, if played on Western instruments, would sound very much the same. I commend bands 1 and 3 on side 1 and band 4 on side 2. There is a little distortion in the final grooves and in spots there is marked low-frequency noise—mike hum or recorder flutter or something.

Complete in Fidelytie
Zounds of Ye Tymes
Cook 1044

Emory Cook is seldom at a loss for new ways to present his wares. He has put together various leftover sounds in a whimsy not quite as funny as the wares are useful. He bills it as a record to end all high-fidelity records, includes a disclaimer against any damage it might cause equipment and against return for any cause. And it is quite a collection indeed. There are big Hy-Fye sounds—several jet planes and three trains, which between them present some almost unique very-low-frequency sounds and an extremely stiff tracking test. Medium-Fye sounds include a painfully real baby, a telephone bell, old cylinder records, some astonishingly real Mexican firecrackers with a lovely transient explosiveness, a 2-cylinder 1892 gas engine with one spark plug removed, a barn-dance fiddler, 10,000 hens and 3 roosters and at least 299% distortion of the organ in the Morelia (Mexico) cathedral. It ends with a whole side of a variety of winds plus some night noises in the wind including a barking dog, katydids, tree frogs, etc.

RAVEL: *Alborada del Gracioso*
Daphnis and Chloe Suites 1 and 2
Andre Cluytens conducting
Orchestra of Radio France
Angel 35054

An excellent showoff, demonstration and test recording although it is rather dead acoustically. The *Alborado* is first class with a deep drum, plucked basses and very sharp and clean tambourine high highs. The *Daphnis Suite 1* has a very delicately orchestrated first part with very subtle high highs; the *War Dance* is on the spectacular side in high highs. The better known *Suite 2* also has some subtle effects requiring good definition to appreciate. Again the high highs are clean and the bass is good. *Dance General* has some fine drums and sharp high highs though, as in the final grooves on the first side, there is a touch of distortion in the peaks. The dynamic range is outstanding.

DEBUSSY: *La Mer and Nocturnes*
Pierre Monteux conducting
Boston Symphony Orchestra
RCA Victor LM-1939

La Mer is one of the most elaborately, cleverly and yet delicately scored of all orchestral works. Here is a recording which with a superb reproducing system will permit one to hear *all* the music almost as well as at a live performance. Especially notable is the second movement *(Play of the Waves)* with its great complexity of color underlaid by notably big and deep drums. The *Nocturnes* are only slightly less demanding. Both sides present a challenge to the definition of playback systems. A superb recording in every respect. END

Name and address of any manufacturer of records mentioned in this column may be obtained by writing Records, RADIO-ELECTRONICS, *154 West 14th St., New York 11, N.Y.*

Technicians' News

NEW NATIONAL COUNCIL

The American Electronic Service Council was formed at a two-day meeting held in Kansas City May 30 and 31, as a new national association of state organizations. Its main objective is to provide a medium through which the members of the service branch of the electronic industry may coordinate their efforts in solving problems of common concern. Other objectives are to promote good will between segments of the electronic industry, to accumulate and disseminate information pertinent to electronic service, to encourage and perpetuate high ethical standards and to provide the electronic service industry with a national voice that may be heard and respected in the halls of Government and business.

A complete slate of officers (listed in the caption of the photo below) was elected.

The bylaws provide that no president may hold office for more than two consecutive one-year terms, that all regional vice presidents be elected rather than appointed and that the organization be composed of state organizations rather than individual members.

TWO NEW MISSOURI GROUPS

St. Charles and Flat River have both formed local associations of TV service firms, Vincent Lutz, Vice President of NATESA, reports.

Temporary officers of the St. Charles association are: president, Fred Mertins; vice president and treasurer, Mel Cullom; secretary, Cyril Echele. The Flat River district association elected Ed Engel, Crystal City, president; Frank Hagget, Desloge, secretary, and Carl Warren, Flat River, treasurer. The two groups are expected to affiliate with TESA of Missouri, Mr. Lutz stated.

TV "SKIP" LIST

Members of TESA–ST. Louis maintain a "skip" list of individuals who have disappeared with mortgaged receivers, passed bad checks or who are notoriously bad payers. This list has been of value in recovering mortgaged receivers which have disappeared from the St. Louis area and have turned up in other parts of the state. The list contains several hundred names and is free to TESA members as well as being available to nonmembers on a subscription basis.

COLOR COURSE A SUCCESS

Forty-six of the technicians who started the Oklahoma City course in color fundamentals and servicing completed the training, with an average final grade of 81. The course was held under the auspices of the Television Service Association of Oklahoma. The lectures were given and tests conducted

Left to right: Murray Barlowe, Bethpage, N. Y., treasurer; Howard Wolfson, Chicago, secretary; Vern B. LaPlante, Toledo, Ohio, director; Forrest L. Baker, San Antonio, Tex., president; Harold Garten, Wichita, Kan., vice president of the third district; Bert Bregenzer, Pittsburgh, executive vice president; Robert Maxwell, Fort Wayne, Ind., director; John Hemak, Minneapolis, director. Not present for the photograph were: John Wheaton, Mineola, N. Y., vice president of the first district; Alexander Weiss, Detroit, vice president of the second district; John F. Janasik, Omaha, Neb., director.

by Willard Hines, maintenance engineer, and Aaron Britton, color coordinator for WKY-TV, Oklahoma City. Materials for the course, including tape recordings and slides, was supplied by RCA via NATESA.

New officers for the association are: president, H. O. Eales (reelected), Oklahoma City; vice president, Floyd Banks, Sapulpa; second vice president, Ed Cones, Oklahoma City; third vice president, Raymond Selby, Kingfisher; secretary-treasurer, William S. Jones, Oklahoma City.

ELECTRONIC FAIR IN L. I.

The Long Island Radio & Television Guild has planned an Electronic Fair, to be held Dec. 6, 7 and 8 at the New York State University, Farmingdale, N. Y. This will be coordinated with a color symposium—a complete slate of lectures on color television. Approximately 20 papers are planned on such topics as color tube development, receiver circuits, color test equipment and alignment techniques.

ELIMINATE PART-TIMERS?

The Council of Radio & Television Associations of Philadelphia at a recent meeting requested the Philadelphia Radio Servicemen's Association (PRSMA) to appoint a committee to discuss the possibility of eliminating the part-time service technician from its ranks. The council's request stated that such members weaken the position of any service dealer organization because of their limited financial responsibility. It was also stated that the part-time technician has less interest in the business of customer-relationship problems of the full-time dealer.

NO SHOW AT MEET

There will be no displays of electronic equipment at the NATESA convention at the Sheraton Hotel Sept. 14 through 16. (Delegates to past conventions will remember that exhibits and technical sessions were often competing with each other.) A letter from the convention committee states: "From our own direct past experiences, and as visitors to other trade shows, we have concluded that such static displays are a thing of the past and not worth the cost to the exhibitor or the sponsor of the show."

TCA INACTIVE

The Television Contractors Association (Philadelphia), one of the earliest TV service dealers organizations, has been declared inactive in a communication from Alfred M. Haas to the Council of Radio & Television Service Associations. (The council has recently required that all member associations certify that they are composed of a minimum of seven active members and hold regular meetings.)

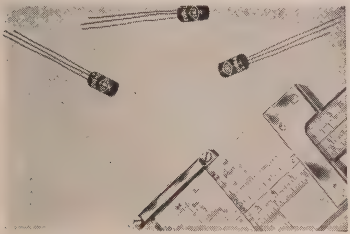
Mr. Haas, who was the president of the association, states he is the only active member of the group. END

new Tubes Transistors

Perhaps as a sign of things to come, this month's releases are dominated by semiconductors—germanium diodes through transistors and phototransistors—indicating the inexorable advancements of these mighty mites.

2N182, 2N183, 2N184

Three new n-p-n alloy-junction germanium transistors, each having a different high-frequency limit, have been announced by CBS-Hytron. Types 2N182, 2N183 and 2N184 (see photo) are similar except for maximum operating frequencies. Type 2N182 reaches its operating limit between 2.5 and 5

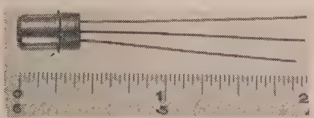


mc; the 2N183 between 5 and 10 mc. Both are recommended for rf, if and oscillator stages in broadcast receivers. The 2N184 reaches its operating limit beyond 10 mc. The 2N183 and 2N184 are recommended for high-speed switching because of their fast response under transient pulse operation.

Their symmetrical design is ideal for switching, flip-flop and bilateral circuits requiring balanced characteristics for switching between emitter and collector for signals of either polarity.

2N223, 2N224, 2N226

Designed for audio stages of transistorized radios, the 2N223, 2N224 and 2N226 are p-n-p medium-power transistors (see photo). These Philco units,



in driver and class-B push-pull operation, produce up to 300 mw audio output at a battery supply of 3 to 12 volts.

These transistors provide extremely linear dc current amplification up to 100 ma of collector current, assuring minimum distortion. Output units 2N226 and 2N224 are available in matched pairs.

2N155

Designed especially for the audio output stage of automobile receivers, the

2N155 is a power transistor scheduled to make its appearance in 1957 car radios. Announced by CBS-Hytron, the 2N155 operates from a 12-volt battery. It is a p-n-p germanium-alloy junction transistor featuring high power gain and uniformity. The unit can be plugged in for easy installation.

The heavy copper-flange mounting (see photo) of the 2N155 permits the flow of heat from the power transistor to the chassis, providing a large radiating area.

2N215, 2N217

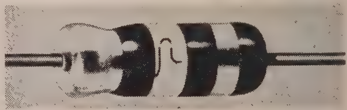
Junction transistors of the germanium p-n-p alloy type, the 2N215 and 2N217, announced by RCA, are flexible-lead versions of the 2N104 and 2N109, respectively. The leads may be soldered or welded into circuits.

The 2N215 is particularly useful in low-power audio applications. In a common-emitter circuit it has a current amplification ratio of 44, a low-frequency power gain of 41 db and a noise factor of 6.5 db.

The 2N217 is intended for large-signal audio applications, especially in class-B push-pull audio output stages of battery-operated portable radios operating at power levels of approximately 150 mw. In a common-emitter circuit this transistor has a large-signal dc current amplification ratio (approximately linear to 50 ma) of 70 and a power gain (for two transistors in a class-B push-pull audio circuit) of 33 db.

1N497–1N502

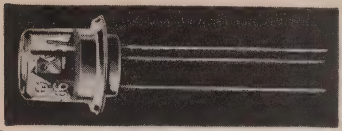
A new series of glass-sealed (see photo) bonded-junction germanium diodes, types 1N497 through 1N502, has been announced by CBS-Hytron. They combine the low forward impedance and reverse current characteristics



of junction devices with the fast forward and reverse pulse recovery of point-contact types. Their wide range of peak reverse voltages and low capacitance make them suitable for varied applications such as computers, magnetic amplifiers, modulators, demodulators and low-power rectifiers.

Phototransistor

A germanium p-n-p alloyed junction three-lead phototransistor, type GT-66, has been announced by General Transistor Corp. The unit is a miniature light-sensitive photocell (see photo) intended for circuits using ac amplification for modulated light. It may also



be used as a two-lead device with dc (unmodulated) light. The GT-66 is capable of performance at a level sufficient to operate a relay.

Applications include automobile headlight dimmers, tape and punch-card reading, optical sound playback, automatic door openers and industrial safety devices. It is also sensitive to the relative position of a light source, making it useful in positioning controls. Typical operation characteristics: collector voltage, −12; collector current, −0.5 ma; sensitivity, 0.16 volt per foot candle.

14SP4, 14QP4, 14QP4A

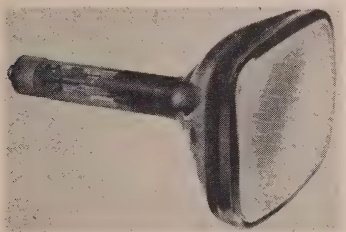
Three new 14-inch picture tubes for portable receivers have been announced by Sylvania. The 14SP4 is a 90° deflection unit offering an 8% larger faceplate area and a space savings of approximately 2 inches in overall length, as compared to 70° types. The tube is glass, rectangular, aluminized and has a standard 1 7/16-inch neck diameter. It uses electrostatic focus and carries a maximum second-anode rating of 15,400 volts. Screen area is about 104 square inches; length 14 3/16 inches.

The 14QP4 and 14QP4A are 70° tubes having approximate screen areas of 96 square inches, electrostatic focus, rectangular faceplate and 12,100-volt maximum second-anode rating. Length is 16 5/32 inches. The 14QP4A is aluminized; the 14QP4 not.

All three have an outer conductive coating which, when grounded, forms a supplementary high-voltage filter capacitor. Each uses a single-field ion-trap magnet.

8XP4

A versatile new television receiver check tube for testing virtually any picture tube from 10 to 27 inches, the 8XP4 (see photo), has been introduced by Sylvania. It is an 8½-inch rectangular unit featuring self-focusing and a parallel-mounted electron gun, eliminating the need for an ion-trap magnet.



No external conductive coating is used.

The 8XP4 may be used in receivers designed for either magnetic or electrostatic focus and to check almost any electromagnetically deflected picture tube, regardless of deflection angle. END

Technotes

RCA RECORD PLAYERS

Several 45-rpm record players came in with the complaint that the record drop was late, the record dropping on the pickup arm after it had moved in. No amount of adjustment of the star wheel remedied the situation.

A slight bending of the star engaging lever toward the star vertices made them operate perfectly again.—*W. R. Brown*

MOTOROLA TV SETS

On most Motorola TV receivers using a 12BH7 in the vertical sweep section, the cathode resistor has too low a wattage rating and will pop due to moisture and heat. On most of these sets the cathode resistor is 8,700 ohms. The trouble can usually be spotted by a horizontal white line or no control of linearity. I have found the best solution is to use a 10-watt resistor in this circuit.—*Paul Banks*

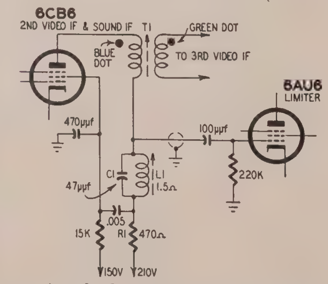
WESTERN AUTO D2919 RADIO

To improve performance on the FM band of this model, replace the 10-μμf capacitor used to couple the 300-ohm antenna to the antenna coil with a 250-μμf unit. This change will produce increased gain and stability.—*Ross Harris*

EMERSON CHASSIS 120196

The sound takeoff in this receiver is run in a shielded cable from the junction of the if transformer T1 and coil L1 to 100-μμf capacitor C1. A short circuit in the cable, from the inner conductor to the shield, burned out 470-ohm decoupling resistor R1.

On replacing the cable and the resistor, the picture had a washed-out appearance and seemed weak. Sound was normal. The schematic (see dia-

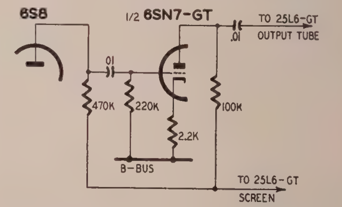


gram) of the set revealed that the short-circuit current which burned up resistor R1 also passed through peaking coil L1, slightly charring it. Although about the proper resistance, the Q was lowered sufficiently to cause the washed-out picture. The coil was replaced and the picture was restored to normal.—*Lawrence Shaw*

RADIO-ELECTRONICS can use illustrated technotes. Diagrams should include no more circuitry than is necessary to explain the technote. Where helpful, photographs are desirable. We do not require unillustrated Technotes at the moment.

EMERSON MODEL 614D

When these receivers become fairly old, it is often impossible to obtain sufficient sound volume. I first considered changing the 6S8 to a 6SJ7 but this meant the addition of crystals for the ratio detector and agc circuits. I finally decided to add another tube

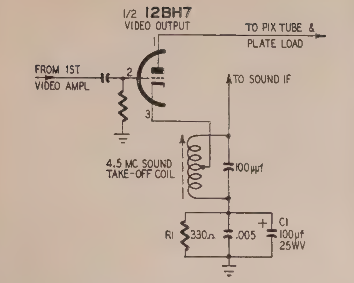


(see diagram) for a second stage of audio. This is not as difficult as it seems even though the set has two series heater strings. The combined heater current of the 300-ma strings is 600 ma which is pulled through the tuner (6J6, 6BC5). The 6SN7 was connected ahead of the tuner.—*Wilbur J. Hantz*

MAJESTIC SERIES 110

After some months of service, this chassis developed a smear, the amount of which could be varied by turning the contrast control in the cathode circuit of the first video amplifier.

Voltage readings disclosed low cathode voltage in the second video amplifier (see diagram). This low bias on the video amplifier caused smear when the video signal was strong enough to overload the video amplifier; varying the contrast control in this case provided sufficient signal voltage to overload the second video output. Testing disclosed that the resistance across R1—330 ohms—was about 40 ohms. Disconnecting bypass capacitor C1 showed



the resistance to be normal. Replacing the defective capacitor restored normal operation.—*Lawrence Shaw*

PRINTED CIRCUIT LEAKAGE

A portion of a midget radio set using a photoetched circuit gave considerable trouble. If the etching fluid is not completely neutralized or removed from the plastic backing of such a circuit, the etch may continue its action. Furthermore, the area which has not been completely cleansed of etching fluid will collect moisture with resultant leakage and receiver trouble such as noise in the audio output.

In this case, the leakage was in the high-frequency oscillator. The noise currents developed by the leakage modulated the oscillator signal with a resultant modulation of the if output of the mixer and noise in the sound. The leakage had another ill effect—reduction of the oscillator output. This produced intermittent oscillator operation from time to time on the lower frequencies (550–750 kc). Scrubbing the affected area with a bristle brush and a very small amount of tooth powder removed the leakage and cleared up the dual complaint of noise and intermittent low-frequency reception.—*Lucian Palmer*

CROSLEY ANTENNAS

All J-Custom and Advance V uhf–vhf TV receivers are shipped from the factory with the Zoomatenna or Supertenna connected to the vhf terminals. In uhf areas these antennas can be used by disconnecting the built-in uhf antenna and transferring the Zoomatenna leads from the vhf to the uhf terminals. In uhf–vhf areas a dpdt switch may be installed so the Zoomantenna can be switched.—*Crosley Service Instruction*

BENDIX T2100

The fusible resistor used in the above models (T19 chassis) may smoke momentarily during the initial warmup period. This is nothing to be concerned about as the smoke should disappear after the receiver is operated once or twice.

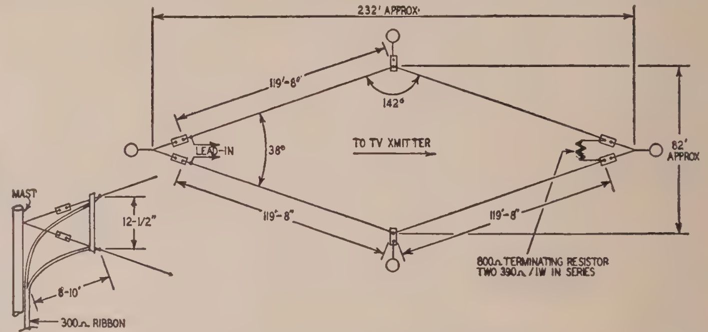
Production procedures involve applying a lacquer coating to the form, its primary purpose being to hold the fuse wire and prevent shorted turns. The lacquer smokes slightly during initial heat cycles.—*Bendix Service Newsletter*

END

Question Box

TV RHOMBIC ANTENNA

Please print a layout diagram for an 8-wavelength rhombic antenna for TV channels 4 and 5. How does the performance of an antenna cut for the mean frequency of these two channels compare with one cut for a single channel? Can I use 50-foot metal poles for support?—M. J. C., San Antonio.



A terminated (nonresonant) rhombic designed with a given number of wavelengths in each leg at the lowest operating frequency will have a higher gain and a greater number of wavelengths per leg at a higher frequency. Thus, a rhombic cut for channel 4 will work with increasing gain on higher channels and performs almost as well on channels 2 and 3. The diagram shows the layout.

The impedance of a single-wire terminated rhombic is approximately 800 ohms. To match the antenna to a 300-ohm lead-in, split 8–10 feet of the ribbon line at the end that connects to the antenna. Fan it out in a V that is about 12½ inches across at the point of connection to the antenna. Keep this section of the line taut and use spreaders to maintain an even taper. See drawing.

This antenna is designed on the basis of a 0° wave angle so somewhat better performance may be had by tilting the antenna so its wave angle (vertical radiation pattern) corresponds to the angle of arrival of the incoming signal. Tilt the antenna horizontally so it slopes 5° to 15° downward toward the terminated end. The lower end should be not less than about 10 feet above ground and the upper end may be up 50 feet or more. Adjust the tilt for maximum reading on a field-strength meter tuned to the highest channel to be received.

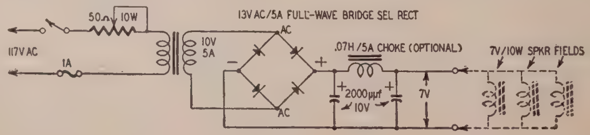
Metal masts may be used if they are not closer than 6 feet or so from the side corners. This precaution is not necessary at the terminated and feed ends but strain type insulators must be avoided here to minimize shunt capacitance.

SPEAKER FIELD SUPPLY

I have several Western Electric model 555 driver units with 7-volt 10-watt fields. Please design a power supply for operating three fields in parallel.—P. L., San Pedro, Calif.

Here is a supply that you can use. The transformer should deliver 9 to 10 volts ac at 5 amps. You can use a 10-volt filament transformer or a dry-disc rectifier transformer such as the Triad F-64U or Tabtran (TAB, 111 Liberty St., New York 6, N. Y.) 5-amp unit. The filter choke is optional and need not be used unless required. This may be a Tabtran type CR6003. A heavy adjustable resistor may be connected in the primary of the transformer to set the output voltage to the required level.

With adequate filtering and current

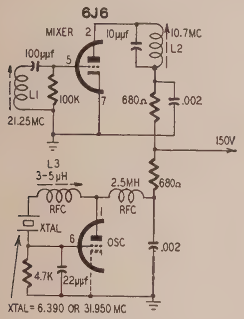


rating, this supply can be used as a 6-volt battery eliminator. Simply select a choke, transformer and rectifier to handle the required current for the desired load.

21 TO 10.7-MC CONVERTER

Please print the diagram of a crystal oscillator and mixer stage that I can use between the 21.25-mc output of a continuous-tuning FM-TV front end and input to a standard 10.7-mc if strip. I'd like to be able to use commercial coils wherever possible.—R. H. B., Milwaukee, Wis.

This 6J6 mixer–oscillator is adapted from a crystal-controlled five-band mobile converter described in recent issues of *The Radio Amateur's Handbook.* The mixer input and output circuits depend on the type of converter transformer on the tuner and the input to the if strip. If the converter transformer is designed to feed into the grid of the first if amplifier at some other point, then you can omit L1 and substitute the secondary of the converter transformer and peak it at the sound if (21.25 mc).



L1 may be a TV sound if coil such as the J. W. Miller type 6171, Meissner 19-1021 or Merit TV-112. If the converter transformer has a link type output circuit wind three or four turns of hookup wire around the ground end of L1 and use link coupling.

For L2 you can use the primary of a 10.7-mc input transformer in the if strip. If the converter cannot be placed close to the input to the strip, then you can use capacitance coupling with a ceramic trimmer of around 40 μμf between the mixer plate and the first if grid. In this case L2 may be a small variable inductor or rf choke with a mid-range inductance of approximately 15 μh.

The oscillator can use a 6.39-mc-fundamental crystal or a 31.95-mc-overtone type. L3 should be tuned for stable output on 31.95 mc. It may be a J. W. Miller type 1055 or 4504 or a North Hills Electric 120-B.

Readers interested in adapting the Inputuner to a 50–240-mc receiver or a converter with 10.7-mc if output are referred to construction details in an article beginning on page 84 of the June, 1956, issue. END

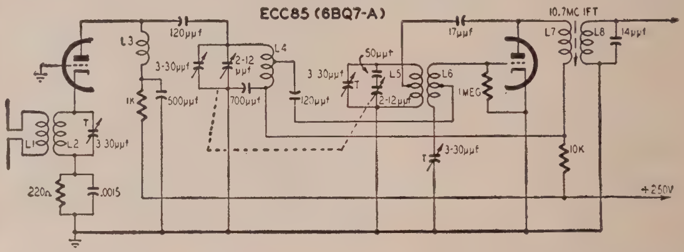
radio-electronic Circuits

1-TUBE FM FRONT-END FOR 10.7-MC IF

This diagram is reprinted from the Radio-Electronic Circuits page of the April, 1955, issue in response to requests for this specific circuit and inquiries on simple FM receiver front ends. This circuit appeared originally in a Mullard application data sheet.

mum noise rather than maximum voltage transfer. Use a noise generator to obtain optimum adjustment.

The second triode is a self-oscillating mixer. Rf voltage is tapped off L4 and fed to the null point on oscillator coil L6 to minimize oscillator radiation and



In this circuit, one triode is a grounded-grid rf amplifier. This simplifies the circuit by eliminating the neutralization required with grounded-cathode triode rf amplifiers. Maximum gain is seldom required from an amplifier in a circuit such as this—its principal function is to isolate the antenna from the oscillator—so input coils L1-L2 can be adjusted for mini-

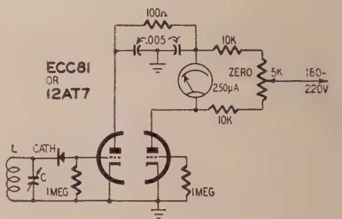
noise. The oscillator circuit is plate-tuned with L5 coupled to the plate through a 17-μμf capacitor. This capacitor also tunes the plate winding of the 10.7-mc if transformer. The grid-plate capacitance of the mixer triode may reduce amplification so some if voltage is tapped off the plate circuit and fed back into the grid circuit at the grounded end of L4.

AMPLIFIED WAVEMETER

The lowly wavemeter is perhaps the most basic frequency-measuring device. It is often used for rough checks of the output frequency of a transmitter, rf amplifier or oscillator when a frequency meter or calibrated receiver is not available. The wavemeter is coupled closely to the circuit under test and then tuned through its range. A pilot lamp lights or a sensitive rf meter deflects when the unknown circuit and the wavemeter are tuned to the same frequency.

The standard wavemeter is not suited for working with transistors and other low-power circuits that do not deliver enough power to light a pilot lamp. A solution to the problem appeared in *L'antenna* (Milan, Italy). The circuit is shown. The pilot lamp

is replaced by a germanium diode and 1-megohm resistor in series across the L-C circuit. This resistor also serves as the input grid resistor of a bridge



type vtvm using an ECC81 or 12AT7. The values of L and C are selected to cover the desired tuning range.

HIGH-IMPEDANCE PROBE

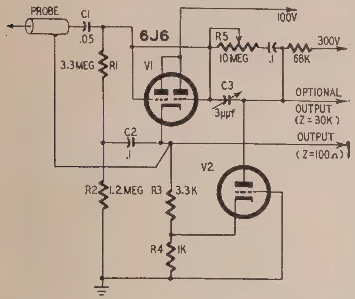
When measuring or observing high-frequency voltages or waveforms from a high-impedance source for reliable results, the input impedance of the probe must be considerably higher than the impedance of the voltage source. A

new type probe with infinitely high input impedance and negligible shunt capacitance is described in patent No. 2,721,908 issued to William W. Moe. A typical circuit is shown in the diagram.

The input tube is a 6J6 cathode fol-

lower with both triodes in parallel. The center conductor of the probe connects to the grids of V1 through C1. The shield of the probe connects to the cathode of the 6J6. The grid–cathode capacitance of the paralleled triodes is approximately 4.4 $\mu\mu f$.

With the circuit constants shown, the gain of the cathode follower is about



0.9 and the input capacitance (probe, cable and grid–cathode capacitance in parallel) is reduced to about 10% of its static value. Similarly, the effective ac resistance of R1 is increased to about 10 times its dc value. C2, R3 and R4 in series have a comparatively low impedance so the apparent value of R1 represents the input resistance of the circuit.

To increase the input resistance and decrease circuit capacitance further, a portion of the output of V1 is taken from the junction of R3 and R4 and fed to V2, a grounded-grid amplifier. This signal is amplified without change in phase and fed back to the grid of V1 through C3 and R5.

R5 and C3 can be adjusted to cancel the effects of residual input capacitance and to increase the input resistance to near infinity.

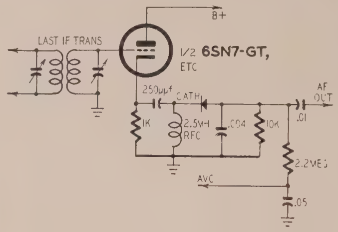
This circuit can be used for other applications where a very high input impedance is needed. For example, it can be used for coupling to a photocell when high output is required with low-level light input.

BETTER DIODE DETECTION

In its usual form the diode detector has two serious limitations. First, it loads the tuned circuit feeding it, thus reducing the selectivity of the tuned circuit and the gain of the if amplifier. Increasing the size of the diode load resistor reduces loading, but dedevelops the second problem—the detection is perfectly linear only when the diode load is a pure dc resistance. In practical circuits there are always resistors coupled to the detector through capacitors, most common being the avc filter and the first audio grid resistors.

Neglecting the capacitor reactances, the parallel combination of all these resistors and the diode load resistor constitute the ac load resistance for the detector. If this is very much less than the dc load resistance, considerable distortion results at high modulation

percentages. Since the values of these shunting resistors are fairly well fixed by other considerations, the maximum possible value of the diode load resistor is similarly limited.

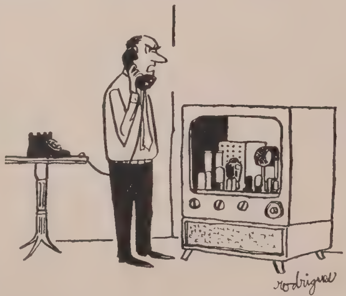


In practice, with avc filter resistors of 2 to 3 meghoms and audio grid reristors of 5 to 10 megohms in most AM sets made today, the diode load resistor is limited by these considerations to around 500,000 ohms. This gives a loading of around 250,000 ohms and, since good modern if transformers have impedances of around 1 megohm, the adverse effect on performance is obvious.

Loading can be minimized by using a cathode follower between the tuned circuit and the detector so it shows a high impedance to the former and a low impedance to the latter, thus operating each under the most desirable conditions.

I chose 10,000 ohms for the diode load resistor, a value which has little effect on the cathode follower's output impedance of about 300 ohms and is negligibly shunted by the usual avc aud audio grid resistors. For distortionless detection the diode impedance must be small compared with the diode load resistance. Vacuum-type diodes do not do so well for the much smaller resistance used here. The best bet is a crystal diode like the high-conductance 1N56.

You may ask why the triode was used as a cathode follower instead of being used as an ordinary infinite-impedance detector. The answer is that the latter detector does not provide an avc voltage and thus a separate diode circuit must be used for that purpose. While ac shunting is of no importance in such a circuit, the tuned circuit is nevertheless loaded by the avc system. In this circuit all outputs are taken from the diode detector without any loading.—*J. Sareda* END



"What do you mean 'how do I know the picture tube is gone?' I can see it's gone!"

Patents

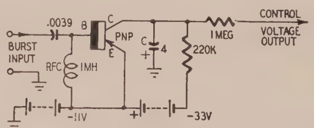
TRANSISTOR COLOR KILLER

Patent No. 2,736,765

Robert D. Lohman, Princeton Junction, and Gerald B. Herzog, Princeton, N. J. (Assigned to RCA)

This circuit automatically switches a receiver from color operation to black-and-white (and vice versa), depending upon whether a TV transmission is color or monochrome. It responds to the burst signal transmitted during a color program.

The transistor in normally blocked since there is no positive bias at the emitter. Therefore C is charged to —44 volts. When the burst arrives (during a colorcast) the alternate half-cycles bias



the transistor to conduction. Thus C now discharges to —11 volts. At the end of the burst the transistor blocks again and C goes back to —33 volts. This difference in capacitor voltage may be used to control a synchonous demodulator and to switch the set from color to monochrome (and vice versa).

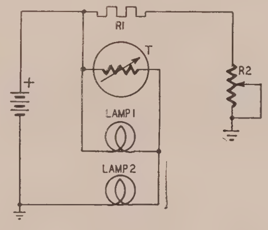
UNDERLOAD–OVERLOAD INDICATOR

Patent No. 2,736,884

Lucien Osborn Yeomans, Babylon, N. Y. (Assigned to AT&T.)

The heart of this circuit is a thermistor which controls a pair of indicating lamps that show whether current flowing through the circuit is over or under the permitted tolerance.

R1 is a heating element for thermistor T. If a weak current is flowing through R1, the thermistor resistance remains high because it is not heated to any great extent. Under this condition there is sufficient current through lamp



1 to light it. Lamp 2, which requires more current, remains dark.

When excessive current flows through R1 into load R2, it radiates considerable heat. The resistance of T falls to a value low enough to short out lamp 1. At this time lamp 2 is effectively across the battery and sufficient current flows to light it.

GAS-TUBE BINARY DEVICE

Patent No. 2,739,235

George Vande Sande, Greece, N. Y. (Assigned to General Railway Signal Co., Rochester, N. Y.)

This circuit can be used for frequency division, trigger service, etc. The gas tube fires once for every pair of cycles fed to it. The signal is a source of square waves that alternately go positive and negative. These waves are applied

The interesting *September* issue of RADIO-ELECTRONICS—On Sale Aug. 23

to both cathode and plate circuits as shown in Fig. 1. Circuit operation is illustrated in Fig. 2 where A is the input to and B the output from the tube.

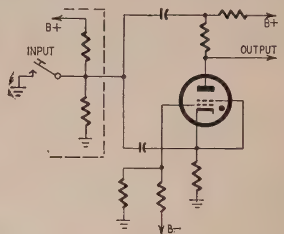


Fig.1

Because of the relatively low-value cathode resistor, this circuit receives a smaller signal voltage than the plate. Also, the cathode time constant is lower, so the signal appears at the cathode before it appears at the plate.

When a gas-filled tube conducts, the grid-cathode voltage has no control. Therefore the positive wave at the cathode cannot block the tube. The negative wave that follows appears

Fig.2

at the plate and drops the current long enough to de-ionize the gas.

Now the tube is nonconducting and a positive wave at the cathode maintains this condition. The next negative wave fires the tube because of the large forward bias on the grid. The negative voltage appears at the plate later than it does at the cathode (due to different time constants). Furthermore, both cathode and plate go negative at this time. This permits the tube to fire and to remain in this condition.

The circuit reverts to the conducting state. The result is that only the negative waves initiate trigger action. For each complete pair of signal waves, there is one cycle of tube operation.

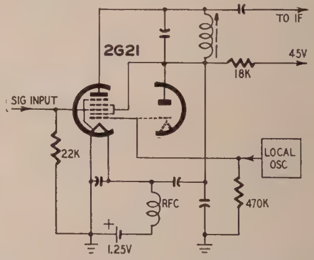
MIXER CIRCUIT

Patent No. 2,726,327

Robert I. Bowen, Waltham, Mass. (Assigned to Raytheon Mfg. Co., Newton, Mass.)

This converter (see diagram) uses a triode-heptode tube. A separate local oscillator injects rf into this 2G21 which mixes it with the signal. The if beat appears at the heptode plate.

In previous circuits the plate of the triode is grounded or left unconnected since it has no



mixer function. This inventor finds that gain may be increased by returning this plate to B plus. Typical component values and voltages are shown.

STABILIZED PIERCE OSCILLATOR

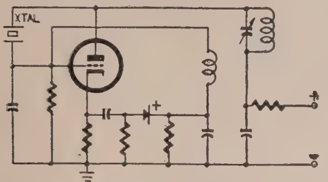
Patent No. 2,724,777

Frank M. Brock, Haddonfield, N. J. (Assigned to Radio Corp. of America)

Conventional crystal oscillators are operated class C. Thus, they generate considerable distortion and harmonic output. Furthermore, the circuits are sensitive to variation in power-supply voltages, and the output amplitude may vary greatly with frequency and coupling. The circuit of Fig. 1 compensates for these variations and distortion. It is a Pierce oscillator. Often

the tank is replaced by a simple rf choke. The circuit will oscillate when the plate circuit is capacitive.

The oscillator, being self-biased, generates a negative grid voltage. With greater excitation, the bias goes deeper into cutoff, and output increases. This results in still greater harmonic



content. To compensate, the cathode voltage is filtered and rectified. The positive voltage is used to control the grid and overcome some of its negative bias.

For example, assume that the excitation increases. Power output will increase and the negative bias will send the tube deep into cutoff. The greater output at the cathode will be rectified by the crystal, providing a higher positive control voltage. This overcomes the high negative bias on the grid and returns the tube to class-B operation.

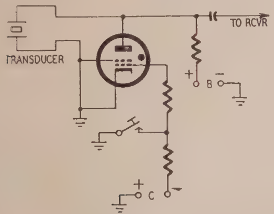
In a typical circuit, the new oscillator showed less than 0.5-db variation in amplitude, as compared with 1.2 db when the plate voltage was changed 6%.

ECHO SOUNDING
Patent No. 2,725,547

Robert A. Fryklund, Dedham, Mass. (Assigned to Raytheon Mfg. Co., Newton, Mass.)

Echo sounding is a process which detects obstacles under water. Ultrasonic vibrations are transmitted through the water and obstacles reflect some of this energy. The time interval between the transmission and reception indicates the distance.

Previous instruments used a magnetostrictive or crystal transducer excited by a capacitor discharging through it. This is not efficient because an ac circuit delivers a maximum of only 50% of its energy to a matched load. The new method strains the crystal nearly to its rupture point by a dc voltage. Thus practically all the energy is delivered and stored in the crystal. Then the crystal is shorted, permitting it to



vibrate at its ultrasonic resonant frequency. The vibrations are damped rapidly to avoid interference with the echoes.

In the diagram, the crystal is strained mechanically by dc from the high-voltage supply. When they key is closed, negative bias is removed from the thyratron which fires, shorting the crystal. This key makes only momentary contact, then returns to its normally open position.

The crystal transmits compressional waves through the water to the target. At the same time, the pulses are transmitted to the receiver to block it and protect it against the surge. An instant later, the receiver is unblocked and is free to pick up any living echoes. END

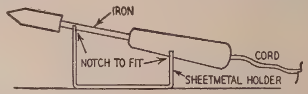
CORRECTION

Transistor types 2N36 and 2N38 were specified for the amplifier circuits in the article "High-Gain Transistor Audio Amplifier" in the June issue. These types are now not generally available. You can substitute a CK721 or OC71 for the 2N36 and a CK722 or OC70 for the 2N38. END

try This one

SOLDERING-IRON REST

When working with the new miniature soldering irons, you must be careful to conserve their heat so they will be hot enough to bring the work quickly to soldering temperature. Thus, it is a good idea to avoid using a conventional stand or stone slab as a rest while using the iron. These dissipate



the heat from the iron so it will not be hot enough when picked up again. I recommend a holder that isolates the iron from heat sinks.

You can use a piece of asbestos or bend a holder from sheet metal as shown. This holder is shaped so its contact with the iron is limited and restricted to parts where heat is low.—*Charles Erwin Cohn*

RECORD-PLAYER TROUBLES

Wows, flutter and stalling in inexpensive record players and changers are often caused by slippage in the drive mechanism. When slippage occurs in a rubber-to-metal system—as between the motor shaft and rubber-tired drive wheel or between drive wheel and turntable rim—it can be eliminated by applying a liberal coat of dial-cord dressing to the inside of the turntable rim and other rotating metal surfaces. —*James V. Cavaseno*

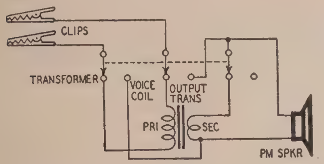
UHF INSTALLATION KINK

Tubular type TV transmission line is often used in uhf installations because the deteriorating effects of dirt and moisture are not as great as on ribbon (flat) lines. When making this type of installation, I insert a short length of 300-ohm ribbon between the tubular line and the antenna terminals on the receiver. This strip of ribbon line—cut a half-wavelength long at the frequency of the uhf station to be received—is then wrapped with a few turns of tinfoil to act as a variable antenna tuner. The foil is positioned for optimum performance on the uhf channel.

The ribbon line is inserted in the lead-in because the tuning effect of the foil is more pronounced on it than on tubular line, thus making it easier to tune out standing waves caused by mismatch between the transmission line and the set.—*Harry J. Miller*

SUBSTITUTION SPEAKER

This little inexpensive substitution speaker permits you to check the audio circuits of most radio and TV sets without using the set's speaker. You need a small PM speaker with matching output transformer for pentodes (a 4-incher will do), a three-pole double-throw switch and a cabinet about 7½ inches wide, 7 inches high and 3 or 4 inches deep.



Wire the switch, speaker and test leads together as shown in the diagram. Now you can select either a direct connection to the voice coil or to the primary of the output transformer. Insulated clip leads are used for connecting to the set under test. I mounted my unit test speaker under a shelf above the bench with the leads hanging on a hook. In this way, it is out of the way yet available for instant use.—*H. L. Matsinger*

ANTENNA ELEMENTS

While experimenting with high-frequency Yagi antennas, I needed a simple and economical method of mounting and adjusting the reflector and director elements on the supporting boom. In a hardware and farm supplies store I ran across some of those electric-fence stakes having spring clips for holding insulators. These clips solved my problem, so I bought a dozen at 4¢ each. Fig. 1 is a closeup of one.

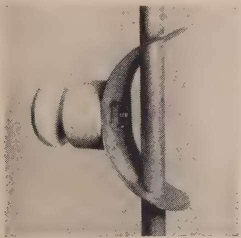


Fig. 1

Fig. 2 shows how pairs of clips were bolted together to make two-way clips that serve three purposes: They hold the reflector and director elements on

Fig. 2

the boom; allow these elements to be adjusted in relation to one another and allow these elements to be centered on the boom. The driven element (a folded dipole in this case) is permanently mounted on the boom.

I used this kink for experimental work but there seems to be no reason why these clips could not be used in a permanent outdoor installation, provided the upper clips were soldered to the boom to keep the elements from tilting due to ice formation or perching birds. Of course, the soldering would be done after the correct spacing of the elements has been found by experiment.

These clips were made to be used with ⅜-inch diameter rod or tubing, but the holes in the clips can be enlarged with a rat-tail file if you want to use ½-inch tubing or rod for either the element or boom.—*Arthur Trauffer*

PROTECT YOUR METER

On outside service calls vacuum-tube voltmeters are subjected to jarring and rough handling that often damages the bearings or other parts of the meter movement. Meter movements that are lightly damped are especially susceptible to damage by sudden jarring or bumping. After ruining an expensive vtvm in this manner, I made a simple modification to prevent a repetition. A spst toggle switch was wired directly across the meter terminals without disturbing the original circuit. With the switch closed, the moving coil of the meter is shorted and sudden jars or bumps will barely move the needle.

To make this modification, first disconnect the meter movement and remove it from the tester. This prevents possible damage from vibration. Drill a hole for the toggle switch as close as practicable to the meter mounting position. Avoid damaging the tester components with the drill. Mount the toggle switch and replace the meter in the panel; then wire the switch directly across the meter terminals and the revision is complete.

If the power switch is mounted near the meter and there is sufficient space on the panel, mount the meter shorting switch next to it. As an alternate, replace the on–off switch with one having an extra set of spst contacts so that turning off the power shorts the meter movement and vice versa. This will eliminate the necessity of turning the meter shorting switch on and off for transporting and testing.

This simple modification is applicable to practically any meter and should cut down the cost of equipment upkeep. —*Warren J. Smith* END

CORRECTION

The new Philco type M-1 transistor announced on page 6 of the June issue was credited with having a gain of 70 db. This is in error. The 70-db figure refers to the gain of the subminiature amplifier shown in the photo at the end of the item.

We thank Thomas Pantages, of Marlboro, Mass., for this correction. END

Business

Merchandising and Promotion

RCA Tube Division, Harrison, N. J., launched an intensive promotional campaign on its service parts at distributor and dealer levels. The four-pronged campaign includes a basic stock program, "Disciplined Inventories—1956,"

a "Distributor Identification Program," a "Dealers Parts Package Program," and a "Dealer Identification Program."

Electro-Voice, Inc., Buchanan, Mich., is promoting its Power-Point phonograph cartridge–needle combination units with a campaign which includes 10 sales aids and a heavy advertising program. The theme of the campaign is "Pete Power-Points the way to

profits," built around a cartoon character "Pete Power-Point."

Thompson Products, Electronics Division, Cleveland, Ohio, developed a summer promotion program for its Superotor antenna rotator. The company is offering distributors a $2 trade-in allowance on any make of old rotator.

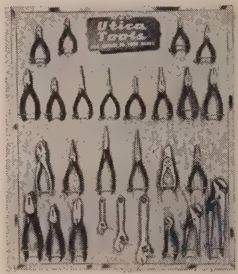
Precision Apparatus Co., Glendale, N. Y., designed a new counter display for its model SS-10 series-string filament checker.

JFD Manufacturing Co., Brooklyn, N. Y., recently advertised its Power-Helix antenna in the *New Haven Register*. The newspaper advertisement was signed by what the company believes is a record number of 94 TV dealers.

Electrovox Co., East Orange, N. J., is promoting its Walco replacement needle sales by incorporating a microscope for needle-point inspection in a merchandising display. The company also announced a new needle display which includes 10 of its top-selling replacement needles.

Dynamic Electronics-New York, Inc., Forest Hills, N. Y., is promoting the sale of its accessories with a new display panel which holds one each of the three new Dynamic TV and FM accessories—audio–video signal attenuator, T121 interference suppression high-pass filter and FM triset coupler.

Utica Drop Forge & Tool Corp., Utica, N. Y., has planned a special sales display unit for tools used in electronic work.



Production and Sales

RETMA reported the production of 2,394,264 TV sets and 4,525,225 radios for the first four months of 1956. This compares with 2,771,426 TV sets and 4,739,919 radios for the 1955 period. TV retail sales for the same period decreased from 2,355,740 in 1955 to 2,036,808 in 1956. Radio sales, exclusive of automobile sets, increased from 1,609,182 in 1955 to 1,984,915 in 1956.

RETMA reported manufacturers' sales of 3,469,405 picture tubes and 155,604,000 receiving tubes for the first four months of 1956 compared with 3,427,745 picture tubes and 152,762,000 receiving tubes in 1955.

New Plants and Expansions

CBS-Hytron, Danvers, Mass., expanded its West Coast facilities in Los Angeles. Leonard M. Murchison was named equipment sales manager of the West Coast and William J. Anderson supervisor of field engineering.

Raytheon Manufacturing Co., Waltham, Mass., exercised its option to lease the Shawsheen mill properties in Andover, Mass., from Textron, Inc. Raytheon has a further option to buy. The 1,000,000-square-foot manufactur-

ing, office and warehouse space will be used to produce military equipment.

Sangamo Electric Co. opened a new sales and engineering office in Chicago. Frank Menghini was named its manager; Calvin De Mars sales engineer and Jack Damewood sales co-ordinator.

Unitronics Corp. has been voted the new name of Olympic Radio & TV, Long Island City, N. Y., and its affiliated companies. Both Olympic and David Bogen Co., another subsidiary, will operate as divisions. The company plans to acquire several additional businesses including a West Coast electronics equipment manufacturer. Olympic leased warehousing and shipping space in Brooklyn, N. Y.

R. H. Hunter Tool Co. is now located in new and larger quarters in Whittier, Calif.

Business Briefs

. . . **RCA Tube Division**, Harrison, N. J., has made available to service technicians a color TV Home Study Course prepared by RCA Institutes.

. . . **Ward Products Corp.**, Cleveland, recently produced its 8,000,000th automobile radio aerial. The photo shows John H. Briggs, president of the Gabriel

Co. (parent company of Ward) receiving the gold plated and mounted antenna from Donald Blech, Ward sales manager, while (left to right) Robert Hood, Ward plant manager; Muggs Pugh, Ward representative; Pat Leone, Ward vice president of manufacturing, and William Rickards, director of engineering, look on. END

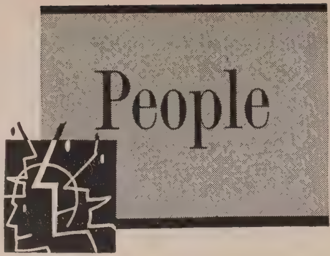
CORRECTIONS

The article on the shirt-pocket radio in the July issue specified MS-126's for if transformers and MS-166 for the antenna loop (with turns removed).

The MS-126 is no longer listed in Lafayette catalogs. Use type MS-268 —three are required, without any circuit changes.

The antenna loop should be MS-272, which matches the tiny variable capacitor. *Do not remove turns.* Tracking and sensitivity are excellent with the loop as provided. As described in the article, about ¼ inch of core may have to be sawed off to fit into the plastic box.

In the review of the book *"Most-Often-Needed 1956 Radio Diagrams and Servicing Information* in the July issue, the first line of the last paragraph refers to 64 diagrams. This is a typographical error. The number of diagrams should be 164.



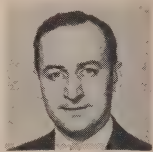
People

Donovan H. Tyson was elected vice president and controller of Allen B. Du Mont Labs, Clifton, N. J. He had been controller of the company since January, 1956.

David J. Munroe (left) was elected president of Webster Electric Co., Racine, Wis. He succeeds **Preston G. Crewe** who was elected vice-chairman of the Board of Directors. **Arthur C. Kleckner** was re-elected chairman of the board.

James R. Ronk (left) was elected vice president of engineering of Howard W. Sams & Co., Indianapolis, and **Lester H. Nelson** (right), general manager of production. Both have been with the company since it was founded.

Harold S. Geneen was elected executive vice president of Raytheon Manufacturing Co., Waltham, Mass. He comes to Raytheon from Jones & Laughlin Steel Corp.



Arch T. Hoyne joined General Cement Manufacturing Co., Rockford, Ill., as sales manager. He has more than 10 years' experience in the parts distribution and was also affiliated with a manufacturers' representative.

Dr. Rodolfo M. Soria, director of engineering for Amphenol Electronics Corp., Chicago, and widely known in the engineering world, was appointed vice president of engineering.

Charles W. Hosterman, assistant general manager of the Electronics Division of Sylvania Electric Products, New York City, was promoted to general manager.


Earl M. Wood (above left), manager of the RCA Tube Division plant in Lancaster, Pa., was promoted to manager–manufacturing, of both the Lancaster and Marion, Ind., plants. **Edward E. Spitzer** (above right), manager–power tube engineering at Lancaster, becomes manager–engineering, at Marion and Lancaster. **Sydney White, Jr.** (at left), manager – power pickup and phototube manufacturing, suceeds Wood as plant manager at Lancaster.

Obituaries

J. R. Nelson, veteran Raytheon Manufacturing Co. engineer and a national authority on radio tube application during the Thirties, at his home in Arlington, Mass., after a short illness, at the age of 56.

Frank V. Goodman who retired as sales manager of Andrea Radio Corp. in 1948 and who previously was a sales executive with American Bosch Co., May 17 at his home in Long Island City, N. Y.

Harold P. Gilpin, retired general sales manager for electronic products of Sylvania Electric Products, at his home in Maplewood, N. J., at the age of 69. END

Thirty-Five Years Ago

In Gernsback Publications

HUGO GERNSBACK, *Founder*

Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

In August 1922 Science and Invention (formerly Electrical Experimenter)

Movies Sent via Radio, by S. R. Winters
Marconi Explains Directional Radio, by A. P. Peck
Radio-Telephone and Aircraft, by S. R. Winters
Power Amplifier and Loud-Speaking Receiver
Radio Concerts for Lighthouses, by E. M. Stevenson
Radio Set in a Table Lamp
The Detectorium—Combined Detector and Tuning Coil
Radio for the Beginner, No. 6, by Armstrong Perry
Insulators from Bottle Necks
Simplest Radiophone Receiver (Winner of Fourth Prize), by J. Twichell Lansing

technical Literature

THERMISTORS

The sixth edition of a comprehensive technical catalog describing Veco thermistors, varistors and assemblies will assist in selecting thermistor or varistor units. It contains complete electrical and physical characteristics covering bead, disc, rod and washer type thermistors, varistors, thermistor assemblies, varistor assemblies and special products such as thermistor hypodermic needles, combustion analyzers, gas analysis cells for vapor phase chromotography and other uses.

Victory Engineering Corp., Springfield Rd., Union, N. J.

RECEIVING TUBES

Design and construction innovations of G-E's microminiature metal ceramic receiving tubes are described in a 20-page booklet *ETD-1212-A*. Application data, operating characteristics and construction features are also given.

G-E Tube Dept., 1 River Rd., Schenectady, N. Y.

CONTROLS AND RESISTORS

Just about every type and size control or resistor for the usual run of applications can be found in *Catalog No. 56*. Among the listings are composition-element and wirewound controls in several sizes including miniaturized versions, field-attached shafts and switches, power rheostats, sound-system controls, precision or laboratory-grade controls; wirewound fixed and adjustable and precision deposited-carbon resistors, ballasts, etc.

Clarostat Mfg. Co., Inc., Dover, N. H.

REPLACEMENT TRANSFORMERS

Triad's 1956 *Television Replacement Guide TV-56* lists correct television replacement transformers for more than 100 manufacturers and 6,000 models.

Triad's general catalog *TR-56* on electronic transformers illustrates and describes nearly 700 items, 76 of which are new to the line.

Triad Transformer Corp., 4055 Redwood Ave., Venice, Calif.

TAPE BULLETIN

A 4-page bulletin describes type EP Audiotape, precision magnetic recording tape for telemetering, electronic computers and other specialized applications. It lists its physical characteristics and magnetic properties and includes a price list of reels of various lengths, tape widths and base-material thickness.

Audio Devices, Inc., 444 Madison Ave., New York 22, N. Y. END

OPPORTUNITY ADLETS

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1,000 BUSINESS CARDS, $3 postpaid. CLARK COBLE, Stilwell 4, Okla.

PROFESSIONAL RECORDING SERVICE: Tapes made, copied, masters cut, processed, pressings made—short runs our specialty—all Ampex 300's, Telefunken & Altec, Hydrofeed Lathes, monofusion presses. COMPONENTS CORP., 106 Main St., Denville, N.J. Phone: Rockaway 9-0290.

TELEVISION Tuner Repairs, DAN'S TELEVISION LABORATORY, 606 Sunrise Highway, Babylon, N. Y.

RULE OTHERS WITH THOUGHTS. Incredible power. (Details—10c). DELMAR WISDOM, 846-S58 Sunnyside Ave., Chicago 40, Ill.

DIAGRAMS FOR REPAIRING RADIOS $1.00. Television $2.00. Give Make, Model. Diagram Service, Box 672-RE, Hartford 1, Conn.

WANTED: **Transmitters:** ART-13/T47A, $175; ART-13/T47, $125; **Altimeters:** BC-788-C, $175; **Transceiver (Complete):** ARC-3, $325; **Transceiver:** ARC-1, $300; **Radio Compass:** R5/ARN-7, $175; **Receiver Modified:** BC-348, $25; **Receiver Unmodified:** BC-348, $50; **Receiver:** BC-342, $50; BC-312, $40; **Indicator:** I-152-C, $50. Ship via Express C.O.D. Subject to Inspection to: H. F. FINNEGAN, 49 Washington Ave., Little Ferry, N.J.

TUBES—TV, RADIO, TRANSMITTING, AND SPECIAL PURPOSE TYPES BOUGHT, SOLD AND EXCHANGED. Send details to R. E. Gensler W2LNI, 512 Broadway, N.Y. 12, N.Y.

ALL MAKES OF ELECTRICAL INSTRUMENTS AND TESTING equipment repaired. Hazelton Instrument Co., 128 Liberty Street, New York, N.Y.

COMPLETE Television Sets $11.95. JONES TV, 1115 Rambler, Pottstown, Pa.

WANTED: AN/APR 4, other, "APR.", "TS-", "IE-", ARC-1, ARC-3, ART-13, BC-348, etc. Microwave Equipment. Everything Surplus. Special tubes. Tec Manuals, Lab Quality Equipment, Meters. Fast Action, Fair Treatment. Top Dollar! Littell, Fairhills Box 26, Dayton 9, Ohio.

DIAGRAMS: Professional Model Timers, Counters, Intercoms, Organs, etc. $1.00 each. List free. Parks, 101 S.E. 57th, Portland 15, Oregon.

WANT a VERY LOW RESONANCE SPEAKER? Ask your dealer to demonstrate the RACON "hi-compliance", floating cone, foam-suspension loudspeaker, or write for literature and prices to RACON ELECTRIC CO., 1261 Broadway, New York 1, N. Y.

FOREIGN jobs list. Technicians needed. $1. RATHE, Box 26131, Los Angeles 26, California.

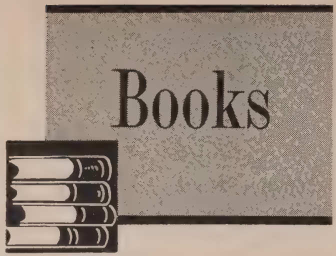
ELECTRONIC TUBES NEEDED: Broadcast (water & air cooled), transmitting, receiving (in quantity only), Magnetrons, Klystrons, etc. TOP PRICES PAID: Write or phone description for immediate action. ROBERT E. SANNET, W6REX, 1524 S. Edris Dr., Los Angeles 25, Calif. Phone: CRestview 1-3856.

HIGH FIDELITY—New, special Collaro RC-54; mounting board; specify Ronette Cartridge or Blank Plug-in Head. $29.95 prepaid. Full line of Hi Fi equipment. Write today. Prompt reply. SOUNDMART, UNLIMITED, 63-03 39th St., Woodside 77, N.Y.

DIAGRAMS! Repair Information! Radios—Amplifiers—recorders $1. Televisions $1.50. Give make, model, chassis.—Norelco-Philips & Amperex tubes in stock! TV MILTIE, Box 101EA, Hicksville, N.Y.

COPYRIGHTED Instructions and diagram for building Antenna Towers. JOHN B. WARE, Route 3, Box 408, Kings Mountain, North Carolina.

17" COLOR Screen $2. Rejuvenator $3. Used TV 10" $35. WORLD EXPORT CO., Box 929, Indio, Calif.



ATOMIC RADIATION, DETECTION AND MEASUREMENT, by Harold S. Renne. Howard W. Sams & Co., Inc., Indianapolis 5, Ind. 5½ x 8½ inches, 198 pages. $3.

Atomic science is in its infancy but growing rapidly. Persons interested in Civil Defense, industrial power and prospecting must know about radiation, its measurement and effects. This is a book that covers the subject in a clear, interesting manner. It describes measuring equipment, both commercial and home-built, dosimeters and atomic applications and gives hints on prospecting.

The first chapters offer an elementary description of atoms and energy and basic counters. Individual following chapters cover commercial, home-built and scintillation counters. Many of these are very simple and can be easily assembled from the diagrams, photos and descriptions. The author does not go deeply into theory at any time, but tells the reader how to build and operate equipment.

Closing chapters discuss the requirements of Civil Defense and successful prospecting. A useful product directory, bibliography and list of definitions round off this book—*IQ*

CLOSED-CIRCUIT AND INDUSTRIAL TELEVISION, by Edward M. Noll. MacMillan Co., 60 Fifth Ave., New York, N. Y. 6 x 9 inches, 230 pages. $4.95.

A text on television transmitting and receiving equipment having applications other than commercial broadcasting. Closed-circuit television has received relatively little publicity and Mr. Noll unveils the technical layout of many present systems and how they do and can serve modern needs.

Written on a television technician level, the book opens with a discussion on the closed-circuit television system. From this point on the text is strictly technical, covering picture transmission, the scanning process and the composite signal, various camera tubes and circuits, video amplifier systems, sync and deflection generators and a detailed discussion on installing and servicing commercial cameras.

Perhaps the most interesting chapter covers in detail much of the Dage and RCA Vidicon closed-circuit equipment, with a very nice discussion on light and optics. An excellent guide for technicians interested in this fast-growing field.—*JK*

MODERN PHYSICS, by Robert L. Sproull. John Wiley & Sons, Inc., New York, N. Y. 5¾ x 9 inches, 491 pages. $7.75.

Modern physics is based on new and radically different theories built up within the past few decades. This up-to-date text describes these theories and shows how they explain atomic and nuclear phenomena. It is written from the standpoint of engineers, at the undergraduate level. The math is not advanced or complicated.

The first chapters introduce the reader to electrons, atoms, energy and waves. By Chapter 5, the reader is ready to understand quantum mechanics, and several examples are worked out. Following chapters discuss energy bands, semiconductors and physical electrons—useful and necessary topics for the electronically minded reader. The final chapter describes radiation, Geiger counters, power reactors and other physical applications.

Throughout the author describes experiments which prove basic relationships and which led to formulation of modern theories. Several atomic tables are included.—*IQ*

MAGNETIC MATERIALS IN THE ELECTRICAL INDUSTRY, by P. R. Bardell. Philosophical Library, New York. 288 pages. $10.

A bridge in the gap between the academic study of magnetic materials and the limited and specialized treatment usually accorded the subject in engineering texts and papers. Each of the nine chapters covering magnetic materials and their applications is complete within itself and may be read at random. Helpful to advanced students in electrical engineering or physics and to engineers and physicists in the industry.

VACUUM VALVES IN PULSE TECHNIQUE, by P. A. Neeteson. (Philips Technical Library) Elsevier Press, Houston, Tex. 170 pages. $4.50.

A new approach to the analysis of networks in which electron tubes are used as switches with detailed operational data on each circuit element. Various types of multivibrators, their operation and application in switching circuits are detailed.

FREQUENCY MODULATION, edited by Alexander Schure. John F. Rider Publisher, Inc., 480 Canal Street, New York 13, N. Y. (Cat. No. 166-3). 5½ x 8½ inches, 46 pages. 90 cents.

This booklet discusses certain principles of frequency modulation: reactance tube circuits, phase modulation, propagation of high-frequency waves. Dipole antennas (dipole) are also described briefly. Details of FM receivers and detectors are not covered.

Very little mathematics is used, but several explanations are based on vector diagrams. Prepared especially as a review.—*IQ* END

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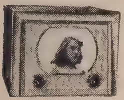

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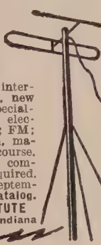

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MS-31

ADVERTISING INDEX

Radio-Electronics does not assume responsibility for any errors appearing in the index below.

SCHOOL DIRECTORY PAGE 119

Baltimore Technical Institute
Candler System Co.
Grantham School
Indiana Technical College
Indianapolis Electronic School
Milwaukee School of Engineering
RCA Institutes, Inc.
Tri-State College
Valparaiso Technical Institute
V.S.I. Television School
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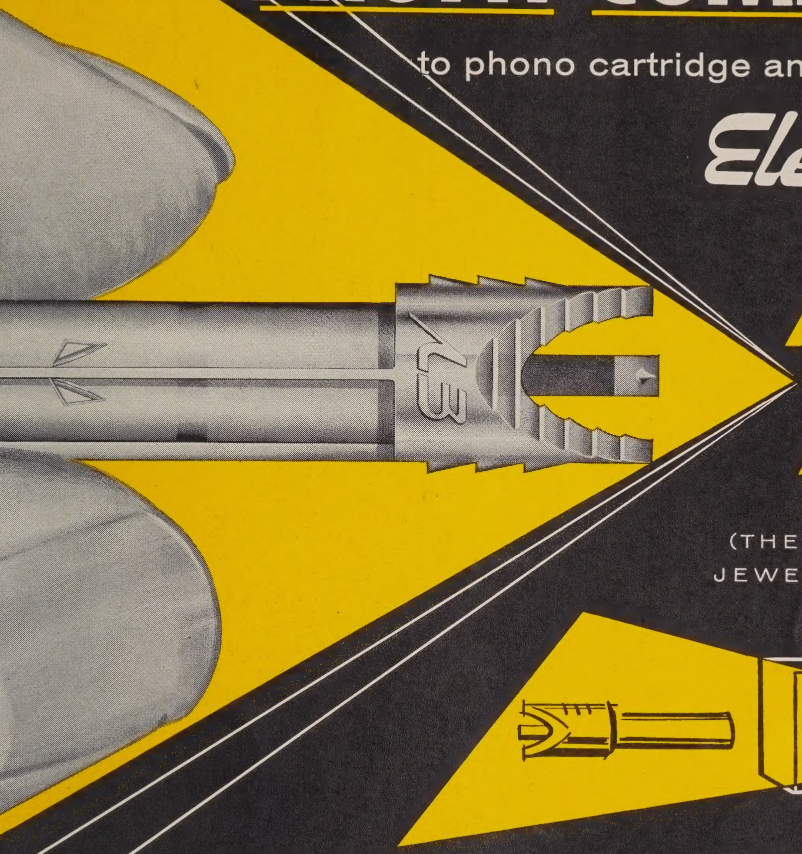
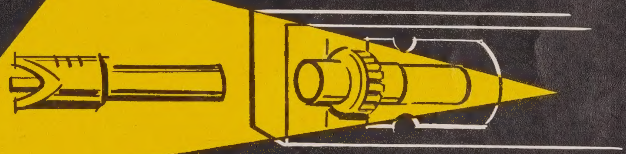


(THE CARTRIDGE WITH JEWELED* PLAYING TIPS)



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